International Trade and Unionization: Evidence from India*

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Abstract

We exploit an exogenous episode of trade liberalization to examine the impact of international trade on unionization and union wages in a developing country. We begin by extending an efficient bargaining framework by allowing for a fixed cost of union formation. This allows us to endogenize the union formation decision and provides us with predictions on the relationship between trade and both unionization and union wages. We then show that these predictions are roughly consistent with those from existing union membership models that have been extended to include international trade. Next, we test our theoretical predictions using a combination of nationally representative household data (National Sample Survey Organization) and nationally representative plant-level data (Annual Survey of Industries) from India. We find that, consistent with our theoretical predictions, net importer industries that experienced larger cuts in tariffs also experienced larger declines in unionization. In addition, we find that net importer industries that experienced larger cuts in tariffs also experienced larger increases in union wages. However, we find that the total wage income losses for deunionized workers exceeds the total wage income gains for unionized workers.

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1 Introduction

Due to a dramatic expansion of international trade, the past few decades have been heralded as a new wave of globalization.[1] A distinguishing feature of this new wave is the unprecedented participation of developing countries. For example, World Bank (2002) points out that the share of developing country manufacturing exports in all manufacturing exports increased from 25% in 1980 to 80% in 1998. Similarly, Goldberg and Pavcnik (2007) identify a long list of developing countries that undertook significant trade reforms during this period. While this unprecedented participation in international trade has undoubtedly brought many benefits, it has also raised concerns about the income of low-skilled workers in these countries.

One of the channels through which trade can lower the income of low-skilled workers is by lowering union density as well as union wages. There are two main ways in which this can occur. First, trade can lower union density and wages by decreasing the rents available for bargaining between the firm and the union. Second, as Rodrik (1997) has pointed out, trade can also lower the bargaining power of workers by making them more replaceable. For example, the importation of final goods can make the products produced by domestic workers more substitutable. In turn, this will lead to domestic workers becoming more substitutable. In addition, the import of intermediate inputs can directly make domestic workers more substitutable. Both of these factors will undermine the bargaining power of unions and thereby diminish a union's ability to compress dispersion in wages.[2] This is a particularly important issue for developing countries as they tend to have relatively lower union density to begin with (Freeman, 2009). Despite this, very little is known about how international trade affects unionization or union wages in a developing country.[3]

We address this gap in the literature by examining the impact of trade on unionization and union wages in India. India provides an ideal setting in which to examine this question for two reasons. First, faced with an acute fiscal crisis in 1991, the newly elected government in India

[1] World Bank (2002) distinguishes between three waves of globalization: the first wave (1870–1914), the second wave (1945–1980), and the new wave (1980 onwards).

[2] See Freeman and Medoff (1984) and Card, Lemieux, and Riddell (2004) for more on the relationship between unionization and wage dispersion.

[3] The only developing country study on this issue we are aware of is Shendy (2010), who finds that trade liberalization in South Africa lowered wages in industries with high levels of unionization.

enacted dramatic trade reforms at the urging of the International Monetary Fund (IMF). By our estimates, tariffs fell from an average of 149.4% in 1988 to 23.9% in 2003. Given that the decision to lower tariffs was done under external pressure, this episode of trade liberalization provides a unique natural experiment that can be used to examine the causal effects of lower tariffs. Second, this was also a period of rapid changes in unionization in India. Our data suggest that the percentage of individuals in unionized activities fell from 34.9% in 1993 to 28.2% in 2004. Similarly, the percentage of individuals that are members of a union fell from 28.3% in 1993 to 21.9% in 2004. Given that trade potentially lowers both the overall rents that can be shared between the firm and the union and the union's share of these rents, one would expect the post-reform period to be one in which union wages in India were decreasing, particularly in net import industries. However, our data suggest otherwise. In fact, we observe a rapid increase in union wages in India with a relatively faster rate of growth in net import industries.

To rationalize these trends in the data, we extend the efficient bargaining framework used in McDonald and Solow (1981) and Brock and Dobbelaere (2006) by allowing for a fixed cost of union formation that enables us to endogenize the union formation decision. We then examine the robustness of our models' prediction by examining the predicted impact of trade on union penetration and membership in other frameworks. In particular, we incorporate trade into the unionization model of Kremer and Olken (2009), which allows for endogenous firm destruction. Next, we examine this issue in the seniority-based model of Grossman (1984) and the "open-shop" models of Naylor and Cripps (1993) and Booth and Chatterji (1995). The latter models are closed-economy ones. We incorporate trade into these models to examine how it is likely to affect union membership.

Overall, these theoretical models provide two main predictions. First, a smaller proportion of workers employed in an industry will be unionized in response to a tariff liberalization. This can happen either because a smaller proportion of firms now experience union penetration or because unions on average have smaller membership. The models we discuss provide a variety of reasons for this effect. First, by lowering the price of final goods in an import-competing unionized industry, trade liberalization lowers the rents available for union-firm bargaining. In addition, trade

liberalization, by lowering union bargaining power, also lowers the share of rents that accrue to unions. Second, in the presence of import competition, unions are less able to guarantee productive employment as import-competing firms shrink as tariffs decline. Finally, with greater turnover of firms in the presence of import competition, maintaining the proportion of firms that are unionized becomes more costly for unions.

Second, despite lowering union penetration, the models we discuss do not provide a clear prediction about how trade will affect union wages. This is because there are two competing forces that drive this relationship. First, as explained above, trade liberalization lowers a union's share of rents. This will lower the income of union members. Second, by lowering the price, trade also lowers output and employment. With diminishing marginal product of labor, the decline in output will be less than proportional to the decline in employment. As a result, the marginal and average product of labor will increase. In turn, this will raise union wages. In fact, if this second effect dominates, then trade liberalization could lead to an overall increase in union wages.

We test these predictions using two sources of data. We use nationally representative household surveys spanning the period 1993–2004 to construct measures of unionization. These data are from the National Sample Survey Organization (NSSO). These surveys ask respondents whether there was any union in their activity and whether they were a member of a union. As these surveys are repeated cross-sections, we aggregate the responses to create an industry-state-year panel. We then use these data to examine the impact of lower industry tariffs on unionization. Consistent with our model's prediction, our results suggest that a decrease in industry tariffs led to a decrease in unionization and union membership in net import industries. This effect was smaller in states with flexible labor markets.

In addition, we also use our data to calculate the median daily union wage at the industry-state-year level. Using these data, we find that a decline in industry tariffs led to an increase in union wages in net import industries. Next, we use a survey of manufacturing plants spanning the period 1993–2004 to examine the mechanism linking trade liberalization, unionization, and union wages in our model. These data are from the Annual Survey of Industries (ASI). We use these data to check whether trade liberalization lowered both rents per plant and employment per plant during

this period. In addition, we also check whether trade liberalization raised the average product of labor. In all three cases, the ASI-based results strongly confirm the mechanisms we highlight in our model.

Our results suggest that the impact of trade liberalization on union wages is not uniform across all unionized workers. On the one hand, we find that a fraction of the initially unionized workers are shifted into nonunion employment due to trade liberalization. As a result, these workers earn the lower nonunion wage. On the other hand, we find that workers that remained unionized after trade liberalization experienced an increase in their wages. To examine this issue further, we conduct a back-of-the-envelope calculation to compare the wage losses to deunionized workers with the wage gains to unionized workers. Our calculations indicate that the total losses to deunionized workers exceed the total gains to unionized workers. Thus, it suggests that even if trade liberalization raises union wages in net importer industries, it need not increase the total wage income of the pool of initially unionized workers in these industries.

Our paper is related to an extensive literature on trade and unionization, with the empirical side focused primarily on developed countries. On the theoretical side, Grossman (1984) examines the impact of trade on union membership and wages, while Mezzetti and Dinopoulos (1991) and Bastos and Kreickemeier (2009) examine the impact of trade on union wage bargaining and therefore on union wages. In addition, Gaston and Trefler (1995), Bastos, Kreickemeier and Wright (2010) examine, both theoretically and empirically, the impact of trade/product market competition on union wages using U.S. and U.K. data respectively. Interestingly, Gaston and Trefler (1995) find that lower tariffs in the U.S. are associated with higher union wages. However, they also find that other measures of trade (i.e. imports and exports) do not support this conclusion. In addition, Bastos et al. (2010) find that, for low levels of unionization, greater product market competition increases union wages in the U.K. However, this effect is reversed for unionization levels above a certain threshold.

A key contribution to the empirical literature on the impact of trade on unionization is the monograph by Baldwin (2003). He examines the role that international trade played in the recent decline in unionization in the U.S. He concludes that trade had a modest effect, if any, on union

patterns and the union-nonunion wage differential in the U.S. Magnani and Prentice (2003) examine the impact of import penetration, among other factors, on unionization across 3-digit industries in the U.S. for the period 1973–1994. They are unable to find an effect that is robust in sign and significance to alternative specifications. Thus, they are unable to arrive at a firm conclusion about the effects of trade on unionization. Dreher and Gaston (2007) study the variation of the overall unionization rate at the country level for 17 OECD countries for the 1980s and 1990s. Using alternative broad measures of globalization and their various components, they find that social integration ("spread of ideas, information, images and people" leading to the "Americanization of institutions") rather than economic integration has led to deunionization. Thus, empirical studies in the trade and unionization literature either focus on how trade affects unionization or how trade affects wages in a unionized setting. In fact, the literature has mainly focused on the latter issue with the former being relatively under-studied. Further, the main focus of this literature has been on developed countries. In contrast, our empirical study of trade and unionization in India (a large developing country) examines the impact of trade on both unionization and union wages.

The remainder of this paper is structured as follows. In section 2 we develop a model of firm and labor union bargaining that endogenizes the union formation decision. This allows us to examine the impact of trade liberalization on unionization and union wages. In section 3 we discuss the data used to construct our measures of unionization and union wages. Next, in section 4 we describe our econometric method. In sections 5 and 6 we discuss our results. Finally, in section 7 we provide a conclusion.

2 Theory

In this section we discuss in detail the theoretical links between international trade, union-firm bargaining and unionization. Our aim here is twofold. First, we use our model to examine the mechanisms that link trade, unionization, and union wages. Second, we also discuss how robust our theoretical predictions are to alternate frameworks. We do this by examining several other models of union-firm interaction, where unionization (union membership or union penetration) is treated

as endogenous. Some of these models assume a closed economy. As a result, they do not allow trade to impact unionization and union wages. In these cases, we introduce trade into the model and, where appropriate, discuss how the resulting predictions differ from those of our own model.

2.1 A Model of Union Penetration With Efficient Bargaining

The model we present in this section is an extension of McDonald and Solow (1981) and Brock and Dobbelaere (2006). We build on their framework by allowing for a fixed cost of union formation, which makes the union formation decision endogenous. In the discussion below, we provide an intuitive description of the model. See section A1 in the appendix for further details.

We consider a setup in which a representative firm in an industry and a labor union bargain over both the wage (w) and employment (N). For tractability, we assume that labor is the only variable input and that all other factor inputs are fixed. In addition, the firm takes the prices of the other fixed inputs as given. The price charged by the firm, P, is a function of the world price (P^*) and the import tariff (τ), so that $P = P^*(1+\tau)$. There is also a risk-neutral labor union whose utility depends on the wage income of union members working at the firm, wN, and the wage income of union members not working at the firm, $(\overline{N} - N)w_a$, where $\overline{N}$ is the total union membership and w_a is the outside wage. The union and the firm engage in Nash bargaining to determine the wage (w) and employment (N).

Next, let us assume that there is a fixed cost, F, that the union has to incur before it can be operational and start negotiating with the firm. In appendix section A1, we show that the solution to this Nash bargaining problem yields the following expression for the net payoff of the union, $\widetilde{U}$, which is its net gain from becoming operational:

$$\widetilde{U} = \beta(1 - \varepsilon_{Q,N})PQ - F \tag{1}$$

where $\varepsilon_{Q,N} = NF_N/Q$ is the elasticity of output (Q) with respect to labor and F_N is the marginal product of labor. Note that $\widetilde{U}$ is the gain over what these N workers would otherwise get, which would be their wage receipts at the outside wage. Let us assume that $\varepsilon_{Q,N}$ is constant. This would

be the case if the firm has a Cobb-Douglas production function.[4] With trade liberalization, i.e. a decrease in τ, $P = P^*(1+\tau)$ falls and so does Q. This means that the total revenue, PQ, decreases. From Eq. (1), it follows that the payoff to the union falls as a result of trade liberalization.

Next, suppose we have a continuum of firms in the industry that are identical in all respects but vary continuously in their resistance to unions.[5] In other words, F varies across firms. Let us index firms in increasing order of fixed costs of a union penetrating the firm. This means that we now have a function, $F(n)$, which is a union's fixed cost of penetrating the nth firm where $F'(n) > 0$. The union's net payoff from penetrating the nth firm is

$$\widetilde{U}(\tau, n) = \beta(1 - \varepsilon_{Q,N})PQ - F(n)$$

with

$$\frac{\partial \widetilde{U}}{\partial n} = -F'(n) < 0 \qquad \text{and} \qquad \frac{\partial \widetilde{U}}{\partial \tau} > 0$$

If $\widetilde{U}(\tau, n) > 0$, then the nth firm will be penetrated by a union. In equilibrium, the number of unionized firms, n^*, will be given by the solution to the following equation:

$$\widetilde{U}(\tau, n^*) = 0 \tag{2}$$

Totally differentiating (2) with respect to τ, we have

$$\frac{dn^*}{d\tau} = \frac{1}{F'(n^*)} \frac{\partial \widetilde{U}}{\partial \tau} > 0$$

Thus, as τ goes down with trade liberalization, we will have a smaller proportion of firms in the industry that are unionized. This leads to our main hypothesis that *tariff liberalization in an industry leads to deunionization in that industry.* To the extent that it is greater import

[4] In appendix section A1, we discuss the implications of letting the firm have a CES production function where ε is no longer constant.

[5] The interpretation here could be as follows. Suppose there are $\overline{R}$ regions, each with one firm producing the good in question and $\overline{N}$ workers. Without loss of generality, we can label firm in region i as firm i. Firms are price-takers and all firms sell in the same market. Both firms and workers are immobile (across regions). If a union penetrates a firm i in a region i, all $\overline{N}$ workers in that region become members of that firm-specific union, of which N are employed by the firm. Firms that are not penetrated by any union pay the alternative or outside wage, w_a.

competition (fall in the prices of imports) due to trade liberalization that leads to deunionization, the deunionization effects are going to be stronger in net-importer industries. Note that, whether unionized or not, each firm's hiring decision is governed by the first-order condition with respect to N (see equation (14)) and so a unionized firm will hire the same number of workers as a nonunionized firm. Thus, in this model, the proportion of workers employed in the industry who are unionized exactly equals the proportion of firms in the industry that are unionized. Thus, as τ goes down with trade liberalization, we also have a smaller proportion of workers in the industry that are unionized.

2.2 Trade and Union Penetration with Endogenous Firm Exit

A limitation of the model above is that it does not allow for endogenous firm exit/destruction. This issue has been examined by Kremer and Olken (2009). In their model, similar to our model presented in the previous subsection, unions try to penetrate firms but firms vary with respect to how difficult it is to unionize them. In particular, managers differ in their "union busting" skills. However, Kremer and Olken (2009) do not examine the impact of trade on endogenous union penetration. In this section, we amend the Kremer and Olken (2009) model to examine the effect of international trade on steady-state levels of union penetration. Unlike the original paper, we will not examine the evolutionary dynamics of union penetration.[6]

As before, we provide here an intuitive description of the Kremer and Olken (2009) model with international trade. See appendix section A2 for further details. The model assumes that there is a continuum of products and that each product is made by a single firm. This is because entry into a product market requires a fixed start-up cost. Once there is a firm in the market, if a second firm were to enter, the two firms would engage in Bertrand competition over an identical product and therefore earn zero profits. This ensures that there is no incentive for entry once a firm exists in a particular product market. This result also ensures that each firm has market power and is able to generate rents that can be extracted by the union. To bring in international trade,

[6] Another paper that examines endogenous union penetration is Lazear (1984). His model is also a closed-economy one. While a number of possible outcomes can arise in the Lazear (1984) model if extended to a setting with international trade, it would be outside the scope of this paper to analyze all of these possibilities.

let us assume that there is a fixed number of products within an industry, which in turn leads to a fixed number of firms within an industry. Each of these firms continues to have market power. Across firms within an industry, the difficulty of organizing workers in a firm differs. Each firm sets employment to maximize profits at a basic wage, which is the effective wage in home production and is also the alternative sector of employment for each worker. If the firm is unionized, the union is able to extract additional wages for its members as well as recoup its expenditure on organizing the firm.

Firms are subject to possible negative productivity shocks that can lead them to exit with a certain hazard rate which is a decreasing function of the firm's unobservable investment. Such investment includes avoiding negligence that could lead to costly lawsuits and research and development to remain competitive with potential rivals. We assume that trade liberalization, in the form of a reduction in the import tariff, reduces the demand for the firm's product. This is because the reduction in tariff lowers the cost of importing an imperfect substitute. The consequent reduction in profits lowers the incentive of the firm to invest, which leads to a higher rate of firm exit. This means that, as a result of trade liberalization, a greater number of old firms (both unionized as well as nonunionized) will be replaced by new firms every period in the new steady state.[7] Thus, to maintain the proportion of firms that are unionized, some of these new firms will have to be unionized. In other words, the union will have to incur the fixed cost of unionizing a fraction of these new entrants. At the same time, the higher rate of exit among incumbent firms will reduce the amount of rents that the union is able to extract. This means that the budget available to the union to organize workers in new firms will decrease. Thus, given the higher cost of organizing new firms and the reduction in rents from exiting firms, it must be the case that the steady-state unionization rate will decrease. Thus, even in this framework where firm exit is endogenous, we still get the same prediction as before, which is that trade liberalization will lower the union penetration rate.

[7] Within a steady state, the number of firms will remain unchanged over time.

2.3 Union Wages With Endogenous Union Penetration

The efficient bargaining framework introduced in section 2.1 can also be used to examine the impact of trade liberalization on union wages. To do so, we can use the first-order conditions of the Nash bargaining problem to write the union wage as follows (see appendix section A1 for further details)

$$w = (1-\beta)w_a + \beta\left(\frac{PQ}{N}\right) \tag{3}$$

This means that the union wage rate is increasing in the revenue per worker, PQ/N. For a given average product, Q/N, the union wage rate goes down as P goes down with trade liberalization. However, we know that N also goes down as P goes down. This reduction in N will result in a decline in output, Q. With diminishing marginal product of labor, it will be the case that Q will fall less than proportionately than N. That is, there will be an increase in the average product of labor. This increase in the average product will counter the direct effect of the reduction in P. Depending on which effect dominates, the average revenue per worker and, therefore, the union wage rate may go up or down.

We next examine what happens to the real wage paid by the firm, where the real wage is measured in units of the firm's actual output. This real wage is given by

$$\begin{aligned} \frac{w}{P} &= (1-\beta)\frac{w_a}{P} + \beta\left(\frac{Q}{N}\right) \\ &= (1-\beta)F_N + \beta\left(\frac{Q}{N}\right) \end{aligned} \tag{4}$$

where we use Eq. (14) to make the substitution in the second line. Eq. (4) states that the real wage is a weighted average of the marginal product and the average product, both of which go up as a result of trade liberalization. This is a result of trade liberalization reducing employment coupled with diminishing marginal product of labor. It is clear that this real wage, w/P, will not only go up due to trade liberalization, it will go up proportionally more than the nominal wage (if the nominal wage also happens to go up).[8]

[8]In addition, note that there may be a reduction in bargaining power, β, due to trade liberalization, as argued first by Rodrik (1997). The reason is that trade liberalization makes domestic labor more replaceable through the

2.4 Trade and Union Wages and Membership with Seniority-Based Layoffs

An alternate framework in which to examine the impact of trade and union wages and membership is provided by Grossman (1984), which extends the Grossman (1983) model to include international trade. In this framework, union members differ in their seniority. Within the union, the wage demand is made through a process of majority voting. This means that the wage demand, which is the actual wage, equals the wage rate that maximizes the welfare of the member with the median seniority. Further, layoffs due to negative technology shocks (and rehires due to positive technology shocks) take place according to seniority in the union. In particular, in the event of a negative technology shock, younger workers are fired first. This creates a stronger wage vs. employment tradeoff for a younger median union member. In particular, if the median union member is young, she knows that a higher wage demand will significantly raise her probability of unemployment. Thus, all else equal, the wage demand made by a union with a young median member will be relatively low. On the other hand, if the median union member is older, then she knows that a higher union wage will lead to a relatively modest increase in her probability of unemployment. Thus, all else equal, the wage demand made by a union with a older median member will be relatively high. It follows that the wage demand made by the union is positively related to the age of the median member. It is important to note here that workers from outside the union can be employed by the firm only after all the union workers have been employed.

What happens to the union wage and membership when there is a reduction in tariffs? We know that this reduction in tariffs will lower the price of the import-competing good and therefore also the value of the marginal product for any given level of employment. For any given wage demand, the probability of layoff for each worker will increase. As a result of this, membership for a given wage will be be lower. However, the impact of the lower tariffs on the union wage is ambiguous. On the one hand, because of the increased probability of layoff arising from trade liberalization, the wage demand for given membership will go down. On the other hand, the membership decline due to the lower tariffs will raise the age of the median member of the union.

increase in the possibilities for substitution of the products it produces with foreign products as well as through the imports of imported inputs. Even if the bargaining power effect lowers union wages, it is still possible for union wages to increase after trade liberalization.

This follows from the assumption that layoffs are based on seniority where younger members are laid off first. The increase in the age of the median member will put upward pressure on the wage. Which of the two effects dominates depends on the elasticity of substitution between labor and other inputs.

2.5 Impact of Trade on Union Wages and Membership with "Open-Shop" Unions

In our efficient bargaining framework in sections 2.1 and 2.2, we assumed that workers in a firm either all belonged to a union or they all did not. In other words, firms were not allowed to have both unionized and nonunionized workers. In this section, we examine the relationship between trade and union membership and union wages with "open-shop" unions. This is a union where membership is not compulsory but the negotiated employee benefits apply to members and non-members alike. Two important papers on endogenous union membership in the case of an "open-shop" unions are Naylor and Cripps (1993) and Booth and Chatterji (1995). In these models, as explained in greater detail in appendix section A3, individuals have an expected utility from joining a union (EU^J) and an expected utility from not joining a union (EU^{NJ}). An individual joins the union if $EU^J > EU^{NJ}$. Naylor and Cripps (1993) and Booth and Chatterji (1995) show that $EU^J > EU^{NJ}$ implies

$$\delta > u(w) - u(w-h) \tag{5}$$

where δ is the benefit from an excludable private good,[9] $u(\cdot)$ is a utility function, w is the wage, and h is the union membership dues per person. The latter is equal to the per member cost of running the union.

Let δ vary across individuals. For a given membership, it will be the case that workers who join the union are those with the highest δ's. Therefore, individuals are arranged in descending order of their δ's. In Figure 1 we have a downward sloping δ curve with respect to total union

[9]One can think of this as a grievance procedure that the union provides where different members value this benefit differently (Booth and Chatterji, 1995). Alternatively, it could be the utility from adhering to the norm of joining a union, which for any member is increasing in the number of members (Naylor and Cripps, 1993).

membership, M.[10] In both models, the negotiated wage increases in union membership, holding other things constant. In the Naylor-Cripps model, greater union membership increases union power as it means there are fewer non-members that the firm can employ during a strike leading to lower strike output, revenue and profits.[11] In the Booth-Chatterji model, a higher membership leading to a lower δ^{median} means a lower combined benefit from employment and union membership for the median member, reducing the concern about the employment-reducing effect of a higher wage. In both cases the membership cost given by $u(w)-u(w-h)$ is downward sloping with respect to M. This is ensured by the concavity of the utility function and the negative relationship between labor demand and wage. The intersection of the δ curve (benefit curve) and the membership cost curve gives us the endogenous union membership.[12]

With trade liberalization, at any given membership level, the negotiated wage will decrease since the value of the marginal product and profits are lower at each employment level. This means that there are fewer rents to share.[13] Thus, the membership cost curve $u(w) - u(w - h)$ will shift up due to the concavity of the utility function. Both union membership M and the negotiated wage w will go down. Note, however, that the real wage faced by the firm given by w/P, where P is the price of the final product of the firm, could actually go up. This is due to the increase in the marginal product (and the average product) arising from a lower employment after trade liberalization and the presence of diminishing returns. In other words, the wage goes down but proportionally by less than the price of the product.

2.6 Hypotheses Derived from Theory

In this section we began by using an efficient-bargaining framework to examine the relationship between trade and union penetration. We also examined this relationship using the Kremer

[10] Note that this ranking holds for any given level of membership. We also assume that this ranking dominates the effect of increased membership on utility from following the norm.

[11] Naylor and Cripps (1993) assume that, if negotiations between the union and the firm fail, there is a strike. In the event of a strike, the firm can only employ non-union workers. Thus, if union membership is high, there are fewer non-members that the firm can turn to if there is a strike.

[12] Stability requires the benefit curve to be steeper than the membership cost curve.

[13] In both of these models, the wage is determined (negotiated) first and, given that wage, the firm determines its profit-maximizing employment level.

and Olken (2009) framework with endogenous firm exit. In both models, the prediction was unambiguous and yielded the following hypothesis:

> ***Hypothesis 1:*** *Greater import competition through tariff liberalization leads to deunionization. That is, a smaller proportion of workers employed in an industry facing greater import competition will be unionized.*

In addition, our efficient bargaining framework, the Grossman (1984) model, and the "open-shop" union literature predicts that trade liberalization will lower union membership. Next, in this section, we also saw that the impact of trade liberalization on union wages is uncertain. Both our efficient bargaining framework and the Grossman (1984) model, which uses a seniority-based approach, has shown that the impact is ambiguous. On the other hand, versions of "open-shop" union models (Naylor and Cripps, 1993 and Booth and Chatterji, 1995) that include trade predict that the union wage declines with trade liberalization. However, the role of labor productivity in determining wage is important in all the above models. Thus, we have the following hypothesis that can be taken to the data.

> ***Hypothesis 2:*** *Greater import competition through tariff liberalization has an ambiguous effect on the nominal union wage rate and the union-nonunion wage ratio, but it is likely to lead to an increase in the real union wage (measured in units of the firm's actual output). This real union wage will go up proportionally more than the nominal wage (if the nominal wage also happens to go up).*

3 Data

The unionization measures used in our empirical work were constructed using data from the "employment-unemployment" household surveys conducted by India's National Sample Survey Organisation (NSSO). We use three rounds of these nationally-representative surveys: round 50

(1993-1994), round 55 (1999-2000), and round 61 (2004-2005).[14] Unfortunately data on unionization were not collected during previous rounds. As a result, we are unable to examine unionization patterns using these data for the pre-1993 period.

The "employment-unemployment" household surveys collect demographic and employment information on all household members. Apart from standard employment information, these surveys also ask respondents about unions in their activity. In particular, individuals were asked whether there was any union/association in their activity (union presence). In addition, individuals were asked, conditional on there being a union/association in their activity, whether they were a union member (union membership). As these surveys are repeated cross-sections, we aggregated individual responses to both questions to the 3-digit industry and state level.[15] The union presence aggregate captures the fraction of individuals in a given industry and state that work in unionized activities. Similarly, the union membership aggregate captures the fraction of individuals in a given industry and state that are members of a union. When calculating these aggregates, we accounted for each individual's sample weights. In addition, we restricted the sample to individuals that were in the labor force, worked in manufacturing industries, and were between the ages of 14 and 65. We also restricted the sample to the fifteen major states in India. Both measures of unionization vary by 3-digit industry, state, and year. The correlation coefficient between them is 0.88.

Table 1 lists the top five and bottom five industries according to both measures of unionization. The reported numbers have been averaged over the period 1993 to 2004. As the numbers suggest, there is a large degree of cross-industry variation. For example, in the "manufacture of railway wagons" industry, 81.6% of individuals report being in activities where there is a union present. On the other hand, in the "manufacture of musical instruments" industry, only 5.6% of individuals report being in activities where there is a union present. There is similar cross-industry variation in the union membership measure. For example, in the "manufacture of railway wagons" industry, 79.8% of individuals report being members of a union. On the other hand, in the "manufacture of

[14] In the remainder of this paper, we refer to each of the three survey years using the first year of the survey. In other words, we refer to 1993-1994 as 1993.

[15] Throughout this paper, industries are classified according to the 1987 National Industrial Classification (NIC). There are 104 such industries in our sample.

wooden and cane boxes" industry, only 3% of individuals report being members of a union.

Table 2 displays the cross-state variation in both measures of unionization. Kerala is the most unionized state with 47.4% of individuals working in unionized activities while 34.3% of individuals are members of a union. On the other hand, Uttar Pradesh is the least unionized state with 20.5% of individuals working in unionized activities while 14.6% of individuals are members of a union. Next, Table 3 lists the trends in unionization by year and various individual characteristics. Panel A lists the trends in the union presence data. The second column suggests that union presence declined by 19% from 34.9% in 1993 to 28.2% in 2004. This percentage decline was lower for workers with at least a secondary education (high-skilled) as compared to workers without a secondary education (low-skilled). In addition, columns (5)–(8) suggest that the percentage decline in union presence was also greater for younger and female workers. Panel B lists the trends in the union membership data. Overall, union membership declined by 22.6% from 28.3% in 1993 to 21.9% in 2004. Once again we observe that the percentage decline in union membership was relatively greater for low-skilled, younger, and female workers.

The "employment-unemployment" household surveys also collected wage data for both unionized and nonunionized workers. These wages represent each respondent's earnings during the week prior to the survey date. We use these data to construct aggregated measures of daily union and nonunion wages. In particular, for each industry, state, and year cell in our sample, we calculate the median wage among all unionized workers in that cell. A unionized worker in this instance is a worker that is a member of a union. This is the default measure of union wages we use in our subsequent analysis.[16] Similarly, to construct nonunion wages, we calculate the median wage among all nonunionized workers in a particular industry, state, and year cell. Both wage measures were deflated using an industry-level wholesale price index. Note that these aggregated measures vary by industry, state, and year. A limitation of the wage data is that it was not consistently defined across the three survey rounds. In particular, in rounds 50 (1993) and 61 (2004), the NSSO's definition of wages excluded 'overtime' payments for additional work done beyond normal working

[16] As a robustness check, we also define a unionized worker as one who is working in an activity where unions are present. All of our key results are robust to this change in definition.

hours. However, in round 55 (1999), the wage data included these 'overtime' payments. Given that there was no information provided on 'overtime' hours worked, we were unable to adjust the round 55 wage data to make it comparable to the other rounds. Instead, we omitted round 55 from our NSSO-based wage analysis.[17]

Next, we construct our net import indicator using data from the NBER-United Nations Trade Data. See Feenstra, Lipsey, Deng, Ma, and Mo (2005) for further details on these data. This dataset provides bilateral trade flows between countries at the 4-digit Standard International Trade Classification (SITC) revision 2 level. We converted India's trade data to the 3-digit National Industrial Classification (NIC) 1987 level.[18] After this conversion, we have access to the total imports and exports for each 3-digit Indian industry in our sample. We then define an industry as a net importer if its average exports over the period 1988–1992 was lower than its average imports during this period. We use these five-year averages to ensure that our net importer indicator is not contaminated by transitory changes in imports and exports in an industry.

Fig. 2 depicts the trends in median daily union wages for both net importer and net exporter industries. To the extent that trade liberalization disproportionately lowers union rents in net importer industries, we would expect union wages in these industries to grow at a slower rate. The trends in Fig. 2 indicate that the opposite is true. Median daily union wages in net importer industries have increased at a faster rate relative to union wages in net exporter industries.

Our analysis also uses industry-level data from the Annual Survey of Industries (ASI) for the period 1993 to 2004. These data are representative of formal sector manufacturing plants in India. We construct these data by combining the industry-level ASI data used in Hasan, Mitra, and Ramaswamy (2007) and Gupta, Hasan, and Kumar (2009) respectively. The combined ASI data are at the 2-digit industry and state level.[19] As with the NSSO data, we restrict the sample

[17] We use all three rounds of data for our unionization analysis.

[18] This conversion involved many steps. First, we used a crosswalk available at Marc-Andreas Muendler's webpage to convert the SITC classification to International Standard Trade Classification (ISIC), revision 2. We then used a crosswalk made available by the United Nations Statistics Division to convert the data from ISIC revision 2 to ISIC revision 3. The latter is identical to the Indian NIC 1998 classification. Lastly, we used our own crosswalk to convert the data from ISIC, revision 3/NIC 1998 to NIC 1987.

[19] The Hasan et al. (2007) data are at the 3-digit NIC 1987 level while the Gupta et al. (2009) data are at the 3-digit NIC 1998 level. Unfortunately, it is not possible to create a consistent crosswalk between 3-digit NIC 1998 and 3-digit NIC 1987. Instead, we are forced to create a crosswalk between 3-digit NIC 1998 and 2-digit NIC 1987.

to the fifteen major states in India. These states are listed in Table 2. Recall that our model suggests that trade will lower unionization by lowering rents per plant. In addition, the model also predicts that, with diminishing marginal product of labor, lower employment due to trade could raise the average product of labor. In turn, this will raise union wages. We use the ASI data to test these mechanisms. That is, we examine whether trade liberalization has affected rents per plant, employment, and the average product of labor in a manner that is consistent with our model's predictions. To preview our findings, Fig. 3 depicts the trends in output per worker for both net importer and net exporter industries.[20] These output per worker values have been deflated by an industry-level wholesale price index. The resulting values are in constant 1993 Rupees. This figure suggests that output per worker has increased at a relatively faster rate in net importer industries. These are also the industries where union wages have increased at a relatively faster rate. This is fully consistent with our model's predictions.

Next, the data on output tariffs are from the Asian Development Bank (ADB) and are an extension of the series used by Hasan et al. (2007). These data cover the period between 1988 and 2003. The original data are at the sector level and were converted to 1987 National Industrial Classification (NIC) industries.[21,22] These data suggest that tariffs fell from an average of 149.4% in 1988 to 23.9% in 2003. Note that these tariffs vary by industry and year, but not by state. Lastly, we use the labor market flexibility classification constructed by Gupta, Hasan, and Kumar (2009). This time-invariant, state-level measure assigns each state a value of 1, 0, or –1. A value of 1 indicates a flexible labor law state while values of 0 and –1 indicates neutral or rigid labor law states respectively. This classification is based on information from Besley and Burgess (2004), Bhattacharjea (2006), and OECD (2007). Summary statistics for all variables reported in the regression tables are listed in Table 4. All monetary values reported in this paper are in constant 1993 Rupees.

This is why our analysis using the ASI data is at the 2-digit NIC 1987 level. Our sample includes 15 such 2-digit industries.

[20]To construct the net importer status of a 2-digit industry, we aggregated our 3-digit trade data described above to the 2-digit level. We then defined a 2-digit industry as a net importer if its total exports over a certain period is lower than its total imports over that period.

[21]We thank Rana Hasan at the ADB for providing us the tariff data.

[22]These sectors do not map to all of the three-digit industries in our sample. In the event that a three-digit industry does not have tariff data, we substitute the appropriate two-digit average tariff.

4 Econometric Method

The model in section 2 makes two predictions: (a) that trade liberalization will lead to deunionization and (b) that trade liberalization will have ambiguous effects on union wages. In addition, we argue in section 2 that these effects will be stronger for net importer industries. We test these predictions below. We begin by examining the relationship between trade liberalization and deunionization using the following econometric specification:

$$\begin{aligned} U_{ist} &= \alpha_u + \beta_1 Tariff_{it-1} + \beta_2 NM_i \times Tariff_{it-1} + \beta_3 Z_{it-1} \\ &\quad + \beta_4 X_{ist} + \theta_i + \theta_s + \theta_t + \varepsilon_{ist} \end{aligned} \tag{6}$$

where U_{ist} is the degree of unionization in a 3-digit industry i, state s, and year t. We use two alternative measures of unionization. Our first measure is the fraction of individuals in a given industry and state that work in unionized activities. We refer to this as union presence. Our second measure is the fraction of individuals in a given industry and state that are members of a union. We refer to this as union membership.

$Tariff_{it-1}$ is the one-year lagged import tariff in 3-digit industry i. To test whether the impact of tariffs depends on the trade orientation of an industry, we add an interaction between $Tariff_{it-1}$ and NM_i. The latter is a time-invariant dummy variable that is one for industries with positive net imports. The inclusion of NM_i into this specification raises endogeneity concerns. In particular, it could be the case that the trade orientation of an industry is correlated with factors that also affect the extent of unionization and union wages in an industry. To address these concerns, we construct NM_i using pre-1993 data. The use of such lagged data minimizes the possibility of endogeneity in this context. In particular, we compare the average exports in an industry over the period 1988–1992 to its average imports over the same time period to classify an industry as a net importer. We use these five-year averages to ensure that our NM indicator is not contaminated by transitory changes in imports and exports in an industry.

Z_{it-1} includes controls for the skill intensity and the degree of competition in an industry.

Both of these factors are likely to affect the degree of unionization. We proxy skill intensity using the one-year lagged ratio of non-production to production workers in an industry. We proxy the degree of competition using the natural logarithm of one-year lagged output per plant in an industry. Both of these industry-level measures are constructed using the ASI data. In Eq. (6) we also include a vector of control variables, X_{ist}, that includes the fraction of casual workers in total employment, the fraction of household employees in total employment, the fraction of workers employed in rural areas, the fraction of old (age > 40) and young (age < 30) workers in total employment, and the fraction of educated workers (secondary education and above) in total employment. All variables included in X_{ist} are aggregated from the NSSO data and vary by industry, state, and year. Lastly, θ_i, θ_s, and θ_t are industry, state, and year fixed effects respectively while ε_{ist} is an error term. Based on Hypothesis 1, we expect β_1 and especially $\beta_1 + \beta_2$ to be positive.

We also estimate a version of Eq. (6) where we interact $Tariff_{it-1}$ and $NM_i \times Tariff_{it-1}$ with a time-invariant categorical variable that classifies states into either flexible, neutral, or rigid labor law categories. Given that greater labor market flexibility is associated with lower levels of unionization throughout the sample period, there is less scope for deunionization in these states.[23] This implies that the effect of trade liberalization on deunionization will be weaker in states with greater labor market flexibility. Lastly, we estimate Eq. (6) separately for various sub-samples. These sub-samples are: (a) workers with at least a secondary education (high-skilled), (b) workers with below secondary education (low-skilled), (c) older workers (age > 40), (d) younger workers (age < 30), (e) male workers, and (f) female workers.

Our second hypothesis in section 2 is that trade liberalization will have ambiguous effects on union wages. We examine this issue by estimating the following econometric specification:

$$\begin{aligned} Ln(W^U_{ist}) &= \delta_0 + \delta_1 Tariff_{it-1} + \delta_2 NM_i \times Tariff_{it-1} + \delta_3 Z_{it-1} \\ &\quad + \delta_4 X_{ist} + \theta_i + \theta_s + \theta_t + \epsilon_{ist} \end{aligned} \tag{7}$$

[23] Over the entire sample period, 29% of workers in flexible labor market states work in unionized activities. In rigid states, this number is 36.1%. Similarly, over the entire sample period, 21.5% of workers in flexible labor market states are members of a union while 30.5% of workers in rigid labor market states are members of a union.

where W_{ist}^U is the median daily wage earned by a unionized worker in 3-digit industry i, state s, and year t and ϵ_{ist} is an error term. All other control variables in Eq. (7) are as defined earlier. As before, we also estimate a version of Eq. (7) that includes interactions between $Tariff_{it-1}$ and $NM_i \times Tariff_{it-1}$ and the labor market flexibility measure. In addition, we also estimate Eq. (7) separately for the six sub-samples listed above.

A general concern with our econometric approach is the potential endogeneity of output tariffs. Endogeneity may arise if both unionization/union wages and output tariffs are correlated with political economy factors such as industry size, lobbying power and so forth. Such concerns are less relevant in our context due to the exogenous nature of the Indian trade reforms of 1991. As mentioned earlier in the paper, the reforms were undertaken as a precondition for obtaining emergency loans from the IMF. Given earlier attempts to avoid IMF loans and the associated conditionalities, the adoption of these reforms came as a surprise (Hasan et al., 2007). Thus, not only were these reforms due to external pressure, the timing of it was such that Indian industries were likely unable to anticipate it. Thus, the changes in tariffs associated with these reforms is likely to be exogenous to political economy factors. In addition, all regressions in this paper include industry fixed effects, which will capture the effect of any time-invariant political economy factors.

A related concern with our econometric strategy is the presence of reverse causality. In particular, it could be the case that unions in India exerted influence over the central government's trade policies. This would imply that post-reform changes in tariffs in India were a function of initial level of unionization and union wages. To examine whether this is the case, we use the following strategy. We first aggregate our unionization and union wages measures by 3-digit industry and year. We then regress current tariffs on one-period lagged unionization and union wages. Here period refers to the various survey years. For example, we regress 1998 tariffs on 1993 unionization levels. These regressions include year and industry fixed effects and are weighted by the total number of workers in an industry. The aim of these regressions is to examine whether levels of unionization and union wages are related to subsequent changes in trade policy.

Finally, to further address endogenenity concerns, we use an instrumental variable (IV) strategy adapted from Goldberg and Pavcnik (2005). We begin by converting our econometric specifi-

cations to first differences. This removes all time-invariant variables that are correlated with both tariffs and unionization or union wages. The endogenous variables are then $(Tariff_{it'_1} - Tariff_{it'_0})$ and $NM_i \times (Tariff_{it'_1} - Tariff_{it'_0})$ where t'_1 and t'_0 represent the year preceding various survey rounds.[24] We then use tariffs that are five-year lagged from t'_0 to instrument the current first-differenced tariffs. For example, for the differenced term $(Tariff_{i,1998} - Tariff_{i,1992})$ we use 1987 tariffs as the instrument. Similarly, for the differenced term $(Tariff_{i,2003} - Tariff_{i,1998})$ we use 1993 tariffs as the instrument. For the interaction between current first-differenced tariffs and the net importer indicator, we use the interaction between this indicator and long-lagged tariff as the instrument. This IV strategy relies on two key assumptions: (a) that there is a strong correlation between long-lagged tariffs and current changes in tariffs and (b) that long-lagged tariffs are uncorrelated with current changes in the error term. These assumptions are likely to be satisfied for the following reasons. First, in addition to lowering tariffs, another objective of the Indian trade reforms of 1991 was to harmonize tariffs across industries. This meant that industries that had high tariffs in a given year received larger tariff changes in subsequent years. This ensures a strong correlation between long-lagged tariffs and current first-differenced tariffs. Second, given the gap between the endogenous variable and the instrument, it is likely that current changes in the error term are far removed from the long-lagged tariffs.

4.1 Mechanisms

We use our ASI data to explore the mechanisms highlighted in our model. In particular, our model suggests that trade liberalization will lower union penetration by lowering the payoffs from forming a union, $\widetilde{U}(\tau, n)$. Using Eq. (13), we can write $\widetilde{U}(\tau, n)$ as

$$\begin{aligned} \widetilde{U}(\tau, n) &= (w - w_a)N - F \\ &= \beta(PQ - w_a N) - F \end{aligned}$$

[24] We use t' to capture the fact that the tariffs used in our regressions are lagged by one year. Thus, $t' = t - 1$ where t refers to the various survey rounds.

The term in brackets is the quasirents earned by a firm (Abowd and Lemieux, 1993). Thus, the equation above indicates that, for a given β and F, trade liberalization alters union penetration through its effect on quasirents. In other words, we should observe larger decreases in quasirents due to trade liberalization in industries that have experienced larger decreases in unionization as a result of trade liberalization.

Similarly, from Eq. (3) we know that the impact of trade liberalization on union wages can be decomposed into two components. On the one hand, trade liberalization will lower P. For a given average product, Q/N, this will lower union wages. On the other hand, trade liberalization will lower both N and Q. With diminishing marginal product of labor, the decline in Q will be less than proportional to the decline in N. As a result, both the average product of labor and the union wage will increase. As we discuss in detail later, our results suggest that trade liberalization raised union wages in net importer industries. Therefore, if our model is accurate then we should also find that trade liberalization has lowered employment and raised average product per worker in net importer industries.

To test for these mechanisms, we run the following regression:

$$\begin{aligned} Ln(QR_{jst}) &= \phi_0 + \phi_1 Tariff_{jt-1} + \phi_2 NM_j \times Tariff_{jt-1} + \phi_3 Z_{jt-1} \\ &= +\varphi_j + \varphi_s + \varphi_t + \vartheta_{jst} \end{aligned} \tag{8}$$

where $Tariff_{jt-1}$, NM_j, and Z_{jt-1} are the 2-digit industry level versions of the variables defined earlier. φ_j, φ_s, and φ_t are 2-digit industry, state, and year fixed effects respectively while ϑ_{jst} is an error term. QR_{jst} is the average quasirents per plant for 2-digit industry j, state s, and year t. Our measure of quasirents is based on Abowd and Lemieux (1993) and is defined as follows

$$QR_{jst} = TR_{jst} - M_{jst} - FE_{jst} - (N_{jst} \times w_{a,jst})$$

where TR is total revenue, M is total material costs, FE is fuel expenses, N is total employment and w_a is the nonunion wage. All of these variables vary by industry, state, and year. TR, M,

FE, and N are constructed using ASI data while w_a is constructed using the NSSO data. Because we only use NSSO wage data for 1993 and 2004, the regression above is restricted to these two years. Next, to examine whether trade liberalization has lowered employment, the wage bill (due to a decline in revenues), and raised average product per worker, we replace $Ln(QR_{jst})$ in Eq. (8) above with the natural logarithm of employment, wage bill, and output per worker respectively. We estimate these regressions using annual data from 1993 to 2004 to ensure that they are comparable to the quasirent regression.

5 Results

5.1 Unionization

Table 5 lists the results from estimating Eq. (6). The dependent variable in columns (1)–(3) is the fraction of workers in a given 3-digit industry and state that work in unionized activities (union presence). Note that all regressions reported in Tables 5–8 include 3-digit industry, state, and year fixed effects. In addition, the standard errors are robust and clustered at the 3-digit industry level. We begin in column (1) by estimating the average effect of trade liberalization on union presence. The coefficient of interest suggests that lower output tariffs, on average, did not have a statistically significant effect on union presence. Next, we describe the coefficient estimates of the control variables included in this regression but not reported in Table 5. The coefficient of skill intensity suggests that union presence was higher in industries with higher ratio of non-production to production workers. On the other hand, we find that industrial concentration did not have a statistically significant effect on union presence. Lastly, we also find that union presence was lower in industry-state pairs where there were more low-skilled workers, younger workers (age < 30), casual workers, household employees, and rural workers. In column (2) we examine whether the impact of trade liberalization on unionization depends on the trade orientation of an industry. To do so, we interact an indicator for whether an industry is a net importer with output tariffs and add it to our specification. The estimates in column (2) suggest that lower output tariffs led to lower union presence in net importer industries, as indicated by the positive and significant coefficient of

the interaction term that is larger in magnitude than the negative coefficient of the tariff level term. In particular, given a 10 percentage point decline in output tariffs, union presence in net importer industries declined by an additional 0.8 percentage points relative to net exporter industries.

In column (3) we examine whether labor market flexibility affects the relationship between trade liberalization and unionization. Given that greater labor market flexibility is associated with lower levels of unionization throughout the sample period, there is less scope for deunionization in these states. This implies that the effect of trade liberalization on deunionization should be weaker in states with greater labor market flexibility. We test this hypothesis by adding two new interaction terms to Eq. (6). The first is an interaction between output tariffs and labor market flexibility while the second is an interaction between output tariffs, net importer indicator, and labor market flexibility. We measure the labor market flexibility of a state by using the classification constructed by Gupta, Hasan, and Kumar (2009). This time-invariant measure classifies states into either flexible, neutral, or rigid labor law categories. The estimates in column (3) indicate that the coefficient of the triple interaction term is negative and significant. This implies that the impact of trade liberalization on deunionization in net importer industries was attenuated in states with flexible labor markets.

Next, in columns (4)–(6) we use union membership as the dependent variable. Union membership is defined as the fraction of workers in a given 3-digit industry and state that are members of a union. The results from using this alternate dependent variable are similar to the earlier findings. In particular, lower import tariffs lead to lower union membership in net importer industries and the coefficient estimates in column (5) suggest that a 10 percentage point decline in output tariffs lowered union membership by an additional 0.8 percentage points in net importer industries relative to net exporters ones. In addition, the labor market flexibility results in column (6) are similar to the earlier results in column (3).

In Table 6 we examine whether the relationship between trade liberalization and unionization holds in various subsamples of the data. In column (1) we restrict the sample to high-skilled workers, i.e. workers with at least a secondary education. The dependent variable in Panel A is the fraction of high-skilled workers in a given 3-digit industry and state that work in unionized

activities. The results suggest that lower output tariffs did not have an additional effect on union presence for high-skilled workers in net importer industries. Next, in column (2) we restrict the sample to low-skilled workers. The results in Panel A suggest that lower output tariffs led to lower union presence for low-skilled workers in net importer industries. In columns (3) and (4) we restrict the sample to old workers (age > 40) and young workers (age < 30) respectively. The dependent variables are calculated in an equivalent manner to those described above. The results in Panel A indicate that trade liberalization lowered union presence in net importer industries for both types of workers. Lastly, in columns (5) and (6) we restrict the sample to male and female workers respectively. Here we find that trade liberalization did not have a statistically significant effect on union presence in net importer industries for either group of workers. In Panel B we repeat the above using union membership as the dependent variable. The results are mostly similar to those of Panel A. The exceptions are columns (3) and (6) where we find that trade liberalization did not have a statistically significant effect on union membership for older workers, but did have such an effect for female workers.

The results in Table 5–6 allow us to draw several broad conclusions. First, there is evidence that trade liberalization, on average, led to greater deunionization for workers in net importer industries. This was true irrespective of whether we used union presence or union membership to measure unionization. Second, we found that the deunionization effects of trade liberalization in net importer industries were generally attenuated in flexible labor market states. Lastly, we found that the deunionization effects of trade liberalization in net importer industries were relatively stronger for low-skilled and younger workers.

5.2 Union Wages

Next, we turn to the relationship between trade liberalization and union wages. In Table 7 we report the results from estimating Eq. (7). These regressions use NSSO-based wage data to examine the effect of trade liberalization on union wages. The dependent variable in columns (1)–(3) is the natural logarithm of the real median daily wage among all unionized workers in a particular 3-digit industry, state, and year cell. Recall that a unionized worker in this instance is a

worker that is a member of a union. Note that all regressions in Table 7 include 3-digit industry, state, and year fixed effects. In addition, the standard errors are robust and clustered at the 3-digit industry level. In column (1) we estimate the average effect of trade liberalization on union wages. As before, the coefficient of output tariffs is not statistically significant. In column (2) we add the interaction between output tariffs and the net importer indicator. The point estimate for the interaction term is negative and highly statistically significant (and is greater in magnitude than the positive and insignificant level term in tariff). It suggests that, given a 10 percentage point decline in output tariffs, real union wages in net importer industries increased by an additional 8.2 percent relative to net exporter industries. In column (3) we examine whether the relationship between trade liberalization and union wages depends on the flexibility of the labor market in a state. The coefficient of the triple interaction term ($NM_i \times Tariff_{it-1} \times LMF_s$) suggests that labor market flexibility does not play an important role in this case.

While the results in Table 7 may be somewhat counterintuitive, they support some of the findings from the previous literature. For example, Gaston and Trefler (1995) examine the impact of trade on union wages using U.S. data. They find that lower tariffs in the U.S. are associated with higher union wages. However, they also find that other measures of trade (i.e. import and export volumes) do not support this conclusion. In addition, Bastos, Kreickemeier and Wright (2010) use U.K. data to examine the relationship between product market competition and union wages. They find that, for low levels of unionization, greater product market competition increases union wages. However, this effect is reversed for unionization levels above a certain threshold.

In section 2 we showed that the impact of trade liberalization on the nominal union wage operated through two channels: (a) the average product of labor channel and (b) the price channel. The latter channel lowers the nominal union wage. On the other hand, we showed that the impact of trade liberalization on the real union wage did not include this price channel. This means that, due to trade liberalization, the real wage will increase proportionately more than the nominal wage (if the nominal wage also happens to go up). To see whether this is true in the data we examine the effect of trade liberalization on the nominal median union wage in columns (4)–(6) of Table 7. The results in column (4) suggest that trade liberalization, on average, did not have a statistically

significant effect on the median nominal union wage. However, in column (5) we find that trade liberalization raised the nominal union wage in net importer industries. By comparing the total effect of output tariffs in columns (2) and (5), we can see that trade liberalization raised the real union wage by more than it raised the nominal union wage in net importer industries. This supports the prediction we made in section 2. Lastly, in column (6) we once again find that labor market flexibility does not play an important role in this context.

In columns (7)–(9) of Table 7 we examine the effect of trade liberalization on the union wage premium. We define union wage premium as the natural logarithm of the ratio of union wages to nonunion wages. In column (7) we find that trade liberalization led to a decrease in the union wage premium, on average. In column (8) we find that the impact of trade liberalization on the union wage premium is attenuated in net importer industries. Lastly, in column (9) we once again find that labor market flexibility does not play an important role in this context.

In Table 8 we examine whether the relationship between trade liberalization and union wages holds in various subsamples of the data. In columns (1) and (2) we restrict the sample to high-skilled and low-skilled workers respectively. The dependent variable in column (1) of Panel A is the natural logarithm of the real median wage among all high-skilled unionized workers in a particular 3-digit industry, state, and year cell. The dependent variable in column (2) is constructed in an equivalent manner. In column (1) of Panel A the point estimate suggests that, given a 10 percentage point decline in output tariffs, real union wages for high-skilled workers in net importer industries increased by an additional 7.5 percent relative to net exporter industries. Next, in column (2) of Panel A the point estimate suggests that, given a 10 percentage point decline in output tariffs, real union wages for low-skilled workers in net importer industries increased by an additional 7.9 percent relative to net exporter industries. In columns (3) and (4) we repeat these regressions for old and young workers respectively. In both cases, we confirm that trade liberalization raised real union wages for workers in net importer industries. Lastly, in columns (5) and (6) we restrict the sample to male and female workers respectively. Once again, in both cases, we find that trade liberalization raised real union wages for workers in net importer industries.

In Panel B we use the median nominal union wage as the dependent variable. The results in

columns (1)–(3) are similar to that of Panel A. However, by comparing columns (4)–(6) in Panels A and B respectively, we find that trade liberalization raised the real union wage by more than it raised the nominal union wage for these subsamples. Lastly, in Panel C we use union wage premium as the dependent variable. The results suggest that trade liberalization did not have a statistically significant effect on the union wage premium for high-skilled workers. However, for old, young, and male workers, we find that trade liberalization lowered the union wage premium but at a slower rate in net importer industries. Lastly, the results in Panel C also suggest that trade liberalization raised the union wage premium for low-skilled and female workers.

To summarize, the results in Table 7–8 suggests that, relative to net exporter industries, trade liberalization raised union wages in net importer industries in the overall sample as well as in all six subsamples that we examined in Table 8. We also found that the labor market flexibility of a state did not affect the relationship between trade liberalization and union wages. Lastly, we found that trade liberalization, on average, lowered the union wage premium. However, this union wage premium reducing effect was weaker in net importer sectors. In addition, for low-skilled and female workers, we found that trade liberalization raised the union wage premium.

Our results suggest that the impact of trade liberalization on union wages is not uniform across all unionized workers. On the one hand, we find that a fraction of the initially unionized workers are shifted into nonunion employment due to trade liberalization. As a result, these workers earn the lower nonunion wage. On the other hand, we find that workers that remained unionized after trade liberalization experienced an increase in their wages. In theory, it is not clear which of these effects is dominant. To see what our results indicate about the relative sizes of these two effects, we conduct the following back-of-the-envelope calculation for workers in the net importer industries.

Our results in column (5) of Table 5 suggest that a 10 percentage point decline in output tariffs lowered union membership by 0.8 percentage points in net importer industries.[25] Thus, given the 79.7 percentage point decline in average output tariffs between 1993 and 2004, our results suggest that trade liberalization lowered union membership in net importer industries by 6.38 percentage

[25]This number is calculated by adding the coefficient of the level effect of output tariffs in column (5) of Table 5 (-0.001) with the coefficient of the interaction term in the same column (0.08).

points. We know that the fraction of unionized workers in the net importer industries in 2004 was 0.263. Our results suggest that union membership would have been 0.327 in the absence of trade liberalization.

Next, our results in column (2) of Table 7 suggest that a 10 percentage point decline in output tariffs raised union wages by 5.8 percent in net importer industries.[26] Thus, given the 79.7 percentage point decline in average output tariffs between 1993 and 2004, our results suggest that trade liberalization raised union wages in net importer industries by 46.23 percent. We know that median daily union wages in the net importer industries in 2004 was Rs. 125.87. Our results suggest that median daily union wages would have been Rs. 114.18 in the absence of trade liberalization.

Thus, the 6.38 percent of total workers in net importer industries who were deunionized as a result of trade liberalization suffered a Rs. 66.9 daily wage loss. This number is derived by subtracting the median daily nonunion wage in 2004 (Rs. 47.28) from the predicted median daily union wage in 2004 in the absence of trade liberalization (Rs. 114.18). Thus, the total wage loss for these workers is $-0.0638 \times LF \times 66.9 = -4.27LF$, where LF refers to the labor force in net importer industries in 2004. On the other hand, the 26.3 percent of all workers in the net importer sectors who remained unionized experienced an increase in their daily wage of Rs. 11.69. This number is derived by subtracting the predicted median daily union wage in the absence of trade liberalization in 2004 (Rs. 114.18) from the actual median daily union wage in 2004 (Rs. 125.87). This implies that the total wage gain for these workers is $+0.263 \times LF \times 11.69 = 3.07LF$. By comparing these two estimates, we can conclude that the total wage losses for deunionized workers exceeds the total wage gain for unionized workers.

5.3 Robustness Checks

As mentioned previously in section 4, a concern with our econometric approach is the potential endogeneity of output tariffs. This may arise if both unionization and output tariffs are correlated with political economy factors such as industry size, lobbying power etc. Such concerns

[26] This number is calculated by adding the coefficient of the level effect of output tariffs in column (2) of Table 7 (0.24) with the coefficient of the interaction term in the same column (-0.82).

are mitigated in our context due to the exogenous nature of the Indian trade reforms of 1991. As mentioned earlier in the paper, the reforms were undertaken as a precondition for obtaining emergency loans from the IMF. In addition, there was significant uncertainty regarding the implementation of the IMF directives. As a result, the changes in tariffs associated with these reforms are likely to be exogenous to political economy factors. In addition, all regressions reported thus far included industry fixed effects, which will capture the effect of any time-invariant political economy factors.

A related concern is the presence of reverse causality. In other words, it could be the case that tariffs are a function of past unionization and union wages. To examine whether this is the case, we regress current tariffs on past industry-level unionization and union wages. In other words, these regressions are at the industry level rather than the industry-state level. We also include industry and time fixed effects in these regressions and weight them by the total number of workers in each industry. The results are reported in Table 9. In column (1) we test whether current output tariffs are related to one-period lagged union presence. Here period refers to the various survey years. Thus, as an example, we are regressing tariffs in 1998 on union presence in 1993. The coefficient of interest in column (1) is statistically insignificant. This is also the case when we replace union presence with union membership, real union wage, and the union wage premium in columns (2), (3), and (4) respectively. The results in this table support the view that post-reform changes in Indian tariffs are not related to past unionization and union wages.[27]

As mentioned before, we further address concerns about the endogeneity of tariffs by employing an instrumental variable (IV) approach adapted from Goldberg and Pavcnik (2005). In particular, we convert our baseline specification to first-differences and then use long-lagged import tariffs to instrument the first-differenced current tariff term.[28] For the first-differenced interaction between

[27]We have also estimated an alternate version where we regressed industry tariffs in a particular year on one-year lagged industry-level unionization and union wages. For example, we regressed 1994 tariffs on 1993 unionization and 2000 tariffs on 1999 unionization. In addition, we regressed 1994 tariffs on 1993 union wages and union wage premium. In all of these cases, the coefficient of interest was statistically insignificant. Recall that our tariff data cover the period between 1988 and 2003. As a result, we were unable to regress 2005 tariffs on 2004 unionization and union wages.

[28]For example, for the differenced term $(Tariff_{i,1998} - Tariff_{i,1992})$ we use 1987 tariffs as the instrument. Similarly, for the for the differenced term $(Tariff_{i,2003} - Tariff_{i,1998})$ we use 1993 tariffs as the instrument.

current output tariffs and the net importer indicator, we use an interaction between the net importer indicator and long-lagged output tariffs as the instrument. See section 4 for further details on the instruments as well a discussion of the assumptions that need to be satisfied for this IV strategy to be valid. These IV results are reported in Table 10. In columns (1) and (2) we estimate an IV regression using the first-differenced version of Eq. (6). In column (1) the dependent variable is union presence in first differences while in column (2) it is union membership in first differences. The coefficients of the interaction term of interest in both columns, while imprecisely estimated, retain the correct sign. The Shea's partial R^2 in columns (1) and (2) ranges from 0.03 to 0.38. In columns (3)–(5) we estimate an IV regression using the first-differenced version of Eq. (7). The dependent variable in column (3) is the real union wage in first differences, in column (4) it is the nominal union wage in first differences, and in column (5) it is the union wage premium in first differences. Once again, the interaction term of interest retains the correct sign in all three columns. In addition, all three interaction coefficient estimates are statistically significant. The Shea's partial R^2 in columns (3)–(5) ranges from 0.10 to 0.84. Thus, overall, the IV estimates are qualitatively similar to the OLS results.

In Table 11 we subject the primary results in this paper to a series of robustness checks. In columns (1)–(4) the dependent variable is union presence. In column (1) we add a measure of delicensing to our baseline specification along with its interaction with the net import indicator. The delicensing measure is an indicator variable that is one for 3-digit industries that have been delicensed and zero otherwise. This is constructed using data from Aghion, Burgess, Redding, and Zilibotti (2008). Our intention here is to capture the fact that the economic reforms initiated in 1991 included more than trade liberalization. Thus, it is possible that these alternate aspects of the reforms are the primary cause of the subsequent changes in unionization and union wages in India. However, the results in column (1) suggest that even after controlling for delicensing, the coefficient of the interaction between output tariffs and the net importer indicator remains positive and significant. The coefficient of the delicensing variable suggests that industries that were delicensed experienced a relative increase in union presence.

In column (2) we replace one-year lagged output tariffs with one-year lagged non-tariff barrier

(NTB) coverage ratios. The coefficient of interest remains highly robust. Next, in columns (3) and (4) we replace output tariffs with input tariffs and the effective rate of protection respectively. In both cases, the interaction between trade protection and the net import indicator remains positive and highly significant. In particular, the results in column (4) suggest that our previous results cannot be entirely explained by changes in input tariffs. These results indicate that output tariffs have an impact on unionization that is over and above that of input tariffs. We've also estimated an alternate version of columns (1)–(4) with union membership as the dependent variable. These results are very similar to the ones presented in Table 11.

In columns (5)–(8) we repeat our robustness checks on Eq. (7). The dependent variable in these columns is the natural logarithm of the real median daily wage among all unionized workers in a particular 3-digit industry, state, and year cell. In column (5) we add our measure of delicensing along with its interaction with NM to the baseline union wage specification. Once again, after adding the delicensing measure, the coefficient of the interaction between output tariffs and the net importer indicator remains robust. In column (6) we replace one-year lagged output tariffs with one-year lagged non-tariff barriers (NTBs). The coefficient of interest again remains highly robust. Finally, in columns (7) and (8) replace output tariffs with input tariffs and the effective rate of protection respectively. In both cases, the interaction between trade protection and the net import indicator remains negative and highly significant. We've also estimated an alternate version of columns (5)–(8) with nominal union wage and union wage premium as the dependent variable respectively. In all cases, the results were robust to the various sensitivity tests.

6 ASI-Based Results

In Table 12 we test the mechanisms highlighted in our model. In particular, our model suggests that trade liberalization lowers unionization by lowering the rents available for bargaining. To test this mechanism, we estimate Eq. (8). In columns (1) and (2) the dependent variable is the natural logarithm of quasirents per plant. This measure varies by industry, state, and year. Note that, as described in detail in section 4.3, quasirents are calculated using non-union wage data from

the NSSO. Because we only use NSSO wage data for 1993 and 2004, the regressions in Table 12 is restricted to these two years. The results in columns (1) and (2) suggest that industries that experienced larger decreases in tariffs also experienced larger decreases in quasirents per plant.

Next, our model also suggests that union wages are increasing in output per worker. With trade liberalization, a reduction in employment could raise output per worker if employment declines at a faster rate than output. That is, if there is diminishing marginal product of labor. This mechanism can explain our finding that trade liberalization has raised union wages in India. To examine this mechanism, we replace the dependent variable in Eq. (8) with output per worker, workers per plant, and wage bill per plant respectively. All of these variables are in natural logarithm. If the mechanism highlighted by our model is correct, then we should observe that trade liberalization lowered employment, wage bill, and raised output per worker. In addition, these effects should be stronger in net importer industries. To ensure that these results are comparable to those in columns (1) and (2), we restrict the sample to annual observations between 1993 and 2004 in columns (3)–(8). The output per worker results are reported in columns (3) and (4) of Table 12. The results suggest that trade liberalization has raised output per worker in the overall sample as well as for net importer industries. Next, the results in columns (5)–(8) test whether trade liberalization has lowered employment per plant and the wage bill per plant. The coefficient estimates strongly support this view. Thus, the results in this table forcefully support the mechanisms highlighted in our model. In other words, they support the view that lower employment due to trade liberalization along with diminishing marginal product of labor can explain our finding that trade liberalization has raised union wages in net importer industries in India.

7 Conclusion

In this paper we addressed a gap in the literature by examining the impact of trade on unionization and union wages in a developing country. We first developed a model that extends the efficient bargaining framework used in McDonald and Solow (1981) and Brock and Dobbelaere (2006), by allowing for a fixed cost of union formation to endogenize the union formation decision.

Our model predicted that trade liberalization in the form of reductions in tariffs leads to a lower likelihood of union formation and a smaller proportion of firms in an industry penetrated by unions in equilibrium. Our model also predicted that the impact of trade liberalization on the union wage and the union-nonunion wage premium is ambiguous.

We then examined other relevant models on union membership and union formation. Since in many cases in this literature the theoretical models are not in the trade context, we extended them to discuss the possibilities that would arise under international trade. These papers include Naylor and Cripps (1993), Booth and Chatterji (1995) and Kremer and Olken (2009). This discussion is preceded by a discussion of the seminal work of Grossman (1983) that is extended to an international trade context in Grossman (1984). Overall, qualitatively, the predictions of the existing literature are similar to those of our stylized model.

We tested the above theoretical predictions using a combination of National Sample Survey Organization (NSSO) and Annual Survey of Industries (ASI) data from India. As these data are repeated cross-sections, our analysis is done at the 3-digit industry by state by year level. We found that unionization indeed does go down in a net importer industries after trade liberalization. We also found that the deunionization effects of trade liberalization in net importer industries are generally attenuated in flexible labor market states. We also found that trade liberalization raised the union wage for workers in net importer industries. We then used the ASI data to show that the wage increase is due to an increase in the average product of labor in these industries. Lastly, we conducted a back-of-the-envelope calculation to compare the wage losses to deunionized workers with the wage gains to unionized workers. Our calculations suggested that the total losses to deunionized workers exceeds the total gains to unionized workers. In other words, this suggests that even if trade liberalization raises union wages in net importer industries, it need not increase the total wage income of the pool of initially unionized workers in these industries.

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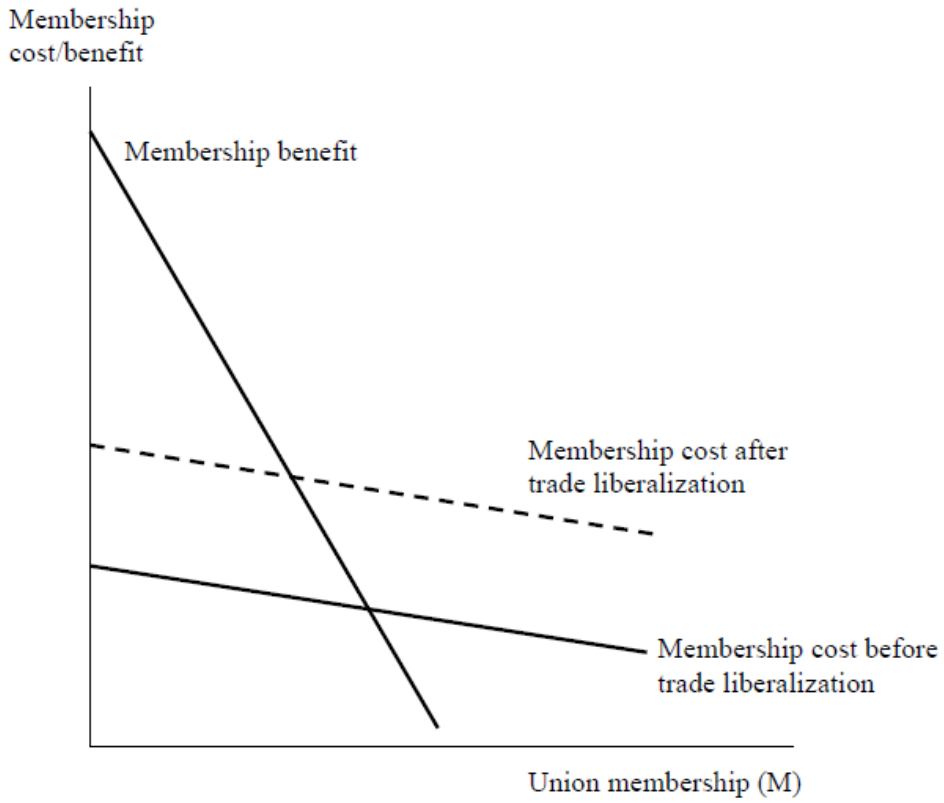

Figure 1: Determination of membership of an open-shop union

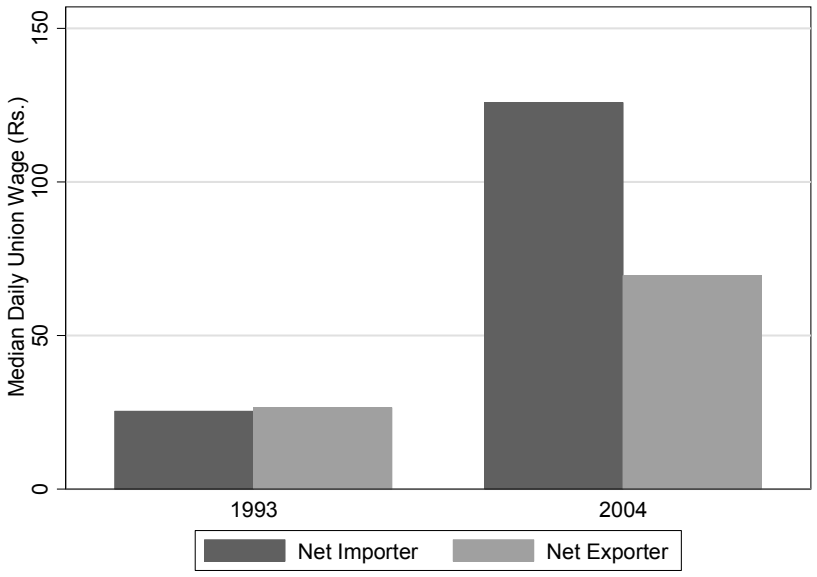

Figure 2: Trends in median daily union wage by industry type. The wage data are from the National Sample Survey Organization's (NSSO) "employment-unemployment" surveys.

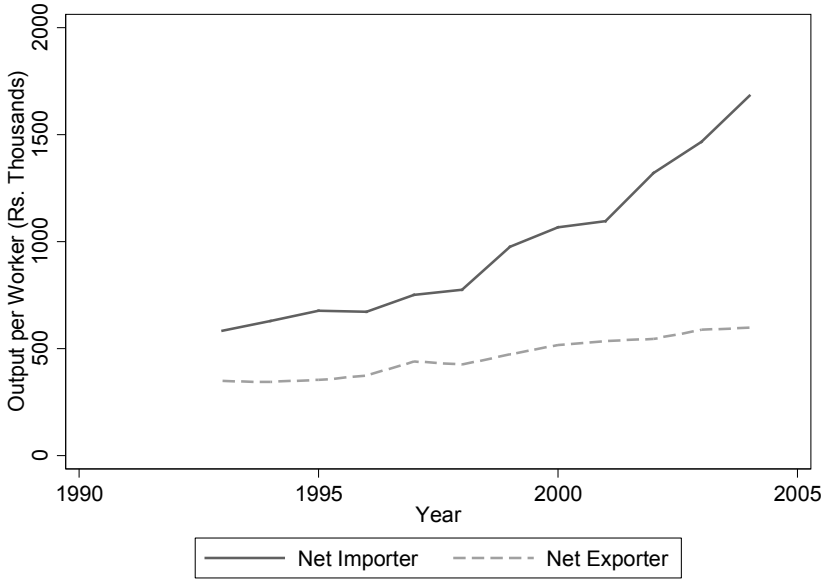

Figure 3: Trends in average industry output per worker. The output and employment data are from the Annual Survey of Industries (ASI).

Table 1: Unionization by Industry

Top Five Industries by Union Presence			Bottom Five Industries by Union Presence		
Code	Description	Unionization	Code	Description	Unionization
372	Manufacture of Railway Wagons	0.816	386	Manufacture of Musical Instruments	0.056
301	Manufacture of Fertilizers and Pesticides	0.710	273	Manufacture of Wooden and Cane Boxes	0.063
314	Manufacture of Refined Petroleum Products	0.705	279	Manufacture of Textile Products n.e.c.	0.083
317	Processing of Nuclear Fuels	0.684	272	Manufacture of Wood, Cane Products n.e.c.	0.083
324	Manufacture of Cement, Lime, and Plaster	0.645	293	Manufacture of Leather Consumer Goods	0.092
Top Five Industries by Union Membership			Bottom Five Industries by Union Membership		
Code	Description	Unionization	Code	Description	Unionization
372	Manufacture of Railway Wagons	0.798	273	Manufacture of Wooden and Cane Boxes	0.030
314	Manufacture of Refined Petroleum Products	0.644	272	Manufacture of Structural Wooden Goods	0.035
301	Manufacture of Fertilizers and Pesticides	0.590	269	Manufacture of Textile Products	0.036
324	Manufacture of Cement, Lime, and Plaster	0.544	279	Manufacture of Wood, Cane Products n.e.c.	0.050
361	Manufacture of Insulated Wires and Cables	0.524	277	Manufacture of Bamboo and Cane Furniture	0.055

Notes: Union presence represents the fraction of workers in an industry working in activities where unions are present. Union membership represents the fraction of workers in an industry that are members of a union. Both measures have been averaged over the three NSSO samples years (1993, 1999, and 2004) before creating this ranking.

Table 2: Unionization by State

State	Union Presence	Union Membership
Andhra Pradesh	0.288	0.211
Assam	0.300	0.245
Bihar	0.270	0.220
Gujarat	0.231	0.184
Haryana	0.269	0.206
Karnataka	0.354	0.283
Kerala	0.474	0.343
Madhya Pradesh	0.249	0.194
Maharashtra	0.390	0.321
Orissa	0.268	0.246
Punjab	0.235	0.179
Rajasthan	0.250	0.202
Tamil Nadu	0.343	0.230
Uttar Pradesh	0.205	0.146
West Bengal	0.385	0.322
Mean	0.305	0.237
Standard Deviation	0.347	0.321

Notes: The unionization rates reported here have been averaged over the three NSSO sample years (1993, 1999, and 2004).

Table 3: Trends in Unionization

	All	High Skilled	Low Skilled	Old	Young	Male	Female
Panel A: Union Presence							
1993	0.349	0.462	0.286	0.392	0.272	0.366	0.198
1999	0.289	0.376	0.218	0.333	0.214	0.299	0.187
2004	0.282	0.356	0.212	0.322	0.204	0.298	0.142
Percentage Change (1993-2004)	-19.00	-22.99	-25.82	-17.79	-25.00	-18.57	-28.35
Panel B: Union Membership							
1993	0.283	0.383	0.222	0.335	0.199	0.300	0.135
1999	0.214	0.291	0.152	0.267	0.140	0.224	0.111
2004	0.219	0.294	0.150	0.268	0.131	0.235	0.081
Percentage Change (1993-2004)	-22.63	-23.35	-32.69	-20.04	-34.17	-21.63	-40.05

Notes: High-skilled workers are those with at least a secondary education. The remaining workers are classified as low-skilled. Old workers are those above 40 years of age while young workers are those below 30 years of age.

Table 4: Summary Statistics

	National Sample Surveys (NSSO)			Annual Survey of Industries (ASI)		
Sample Years	1993, 1999, 2004			1993–2004		
Level of Industrial Aggregation	3-Digit NIC 1987			2-Digit NIC 1987		
	Observ-ations	Mean	Standard Deviation	Observ-ations	Mean	Standard Deviation
Union Presence	3361	0.305	0.347	-	-	-
Union Membership	3361	0.238	0.321	-	-	-
Ln(Real Union Wage)	1853	3.892	0.891	-	-	-
Ln(Nominal Union Wage)	1853	4.141	1.054	-	-	-
Ln(Union Wage Premium)	1833	0.453	0.710	-	-	-
Output Tariffs (One-Year Lagged)	3361	0.567	0.362	2625	0.504	0.252
Output NTBs (One-Year Lagged)	3361	0.339	0.307	-	-	-
Input Tariffs (One-Year Lagged)	3361	0.576	0.360	-	-	-
Effective Rate of Protection (One-Year Lagged)	3361	0.524	0.446	-	-	-
Net Importer	3361	0.445	0.497	2625	0.602	0.489
Labor Market Flexibility	3361	0.153	0.747	-	-	-
Delicensing	3361	0.804	0.397	-	-	-
Ln(Quasirents per Plant)	-	-	-	325	9.124	1.239
Ln(Output per Worker)	-	-	-	2625	6.301	0.806
Ln(Workers per Plant)	-	-	-	2625	4.066	0.708
Ln(Wage Bill per Plant)	-	-	-	2625	16.352	2.098

Notes: The union wage premium is the ratio of union wages to nonunion wages. The union wage, union wage premium, and quasirents per plant variables are calculated using 1993 and 2004 data. This is why their sample sizes are smaller. Concentration is the average output per plant in an industry. All monetary values above are in 1993 Rupees. 1 US dollar in 1993 was approximately equal to Rs. 31.

Table 5: Trade Liberalization and Unionization

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable	Union Presence			Union Membership		
Output Tariffs	-0.01	-0.05	-0.04	0.04	-0.001	0.01
	(0.052)	(0.055)	(0.055)	(0.039)	(0.036)	(0.037)
Output Tariffs × Net		0.08**	0.09**		0.08**	0.08**
Importer		(0.038)	(0.039)		(0.035)	(0.037)
Output Tariffs × Labor			-0.004			-0.02
Market Flexibility (LMF)			(0.018)			(0.015)
Output Tariffs × Net			-0.07***			-0.05***
Importer × LMF			(0.017)			(0.015)
Constant	0.61***	0.71***	0.71***	0.21*	0.30***	0.30***
	(0.170)	(0.178)	(0.179)	(0.109)	(0.106)	(0.106)
Observations	3,361	3,361	3,361	3,361	3,361	3,361
R-squared	0.564	0.566	0.569	0.562	0.564	0.568

Notes: The dependent variable in columns (1)–(3) is the fraction of individuals in a given industry and state that work in unionized activities. The dependent variable in columns (4)–(6) is the fraction of individuals in a given industry and state that are members of a union. Output tariffs are at the 3-digit industry level and are lagged by one year. The labor market flexibility measure is from Gupta, Hasan, and Kumar (2009). All regressions include industry-level controls for skill intensity and concentration and industry-state-level controls for the fraction of casual, household, rural, highly educated, old, and young workers. All regressions are weighted by the total number of workers in each industry and state pair and include state, industry, and year fixed effects. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Trade Liberalization and Unionization: The Role of Individual Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	High Skilled	Low Skilled	Old	Young	Male	Female
Panel A: Union Presence						
Output Tariffs	0.14	-0.07	-0.05	-0.04	-0.05	0.00
	(0.093)	(0.072)	(0.065)	(0.064)	(0.054)	(0.183)
Output Tariffs × Net Importer	-0.02	0.07*	0.09*	0.11**	0.06	0.12
	(0.062)	(0.040)	(0.046)	(0.045)	(0.036)	(0.082)
Observations	2,678	2,871	2,631	2,752	3,284	1,549
R-squared	0.388	0.483	0.516	0.414	0.563	0.378
Panel B: Union Membership						
Output Tariffs	0.19*	-0.03	0.08	-0.03	0.01	-0.01
	(0.099)	(0.040)	(0.054)	(0.041)	(0.044)	(0.088)
Output Tariffs × Net Importer	-0.004	0.07**	0.05	0.14***	0.06	0.15**
	(0.069)	(0.032)	(0.050)	(0.040)	(0.037)	(0.062)
Observations	2,678	2,871	2,631	2,752	3,284	1,549
R-squared	0.374	0.467	0.511	0.371	0.533	0.396

Notes: The dependent variable in Panel A is the fraction of individuals in a given industry and state that work in unionized activities in various subsamples of the data. The dependent variable in Panel B is the fraction of individuals in a given industry and state that are members of a union in various subsamples of the data. High-skilled workers are those with at least a secondary education. Old workers are those above 40 years of age. Young workers are those below 30 years of age. Output tariffs are at the 3-digit industry level and are lagged by one year. All regressions include industry-level controls for skill intensity and concentration and industry-state-level controls for the fraction of casual, household, rural, highly educated, old, and young workers. All regressions include a constant that is not reported and are weighted by the total number of workers in each industry and state pair. They also include state, industry, and year fixed effects. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Trade Liberalization and Union Wages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable	Ln(Real Union Wage)			Ln(Nominal Union Wage)			Union Wage Premium		
Output Tariffs	-0.18	0.24	0.21	0.29	0.68***	0.66***	0.48*	0.80***	0.78***
	(0.276)	(0.200)	(0.197)	(0.261)	(0.184)	(0.183)	(0.252)	(0.202)	(0.201)
Output Tariffs × Net		-0.82***	-0.81***		-0.77***	-0.75***		-0.65***	-0.64***
Importer		(0.140)	(0.144)		(0.146)	(0.147)		(0.152)	(0.154)
Output Tariffs × Labor			0.10**			0.10**			0.07
Market Flexibility (LMF)			(0.046)			(0.046)			(0.041)
Output Tariffs × Net			0.06			0.06			0.10**
Importer × LMF			(0.052)			(0.051)			(0.042)
Constant	2.58***	1.39**	1.37**	1.94*	0.83	0.82	-1.35	-2.29**	-2.29**
	(0.853)	(0.595)	(0.574)	(1.035)	(0.914)	(0.912)	(1.003)	(0.921)	(0.918)
Observations	1,853	1,853	1,853	1,853	1,853	1,853	1,833	1,833	1,833
R-squared	0.678	0.702	0.705	0.791	0.805	0.807	0.434	0.457	0.460

Notes: The dependent variable in columns (1)–(3) is the real median wage earned by union members in a particular industry and state. In columns (4)–(6), the dependent variable is the nominal median wage earned by union members in a particular industry and state. In columns (7)–(9), the dependent variable is the natural logarithm of the ratio of median union wage and median nonunion wage in a particular industry and state. Sample sizes in columns (7)–(9) are lower because not all 3-digit industry and state pairs have nonunion wage data. Output tariffs are at the 3-digit industry level and are lagged by one year. All regressions include industry-level controls for skill intensity and concentration and industry-state-level controls for the fraction of casual, household, rural, highly educated, old, and young workers. All regressions are weighted by the total number of workers in each industry and state pair and include state, industry, and year fixed effects. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Trade Liberalization and Union Wages: The Role of Individual Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)
	High Skilled	Low Skilled	Old	Young	Male	Female
Panel A: Ln(Real Union Wage)						
Output Tariffs	-0.02	-0.22	-0.07	0.36	0.24	0.71***
	(0.401)	(0.174)	(0.190)	(0.254)	(0.201)	(0.221)
Output Tariffs × Net Importer	-0.75***	-0.79***	-0.94***	-0.54***	-0.75***	-1.47***
	(0.219)	(0.116)	(0.122)	(0.181)	(0.141)	(0.182)
Observations	1,575	1,586	1,546	1,428	1,837	599
R-squared	0.716	0.670	0.749	0.659	0.729	0.810
Panel B: Ln(Nominal Union Wage)						
Output Tariffs	0.38	0.20	0.34**	0.78***	0.68***	1.14***
	(0.344)	(0.131)	(0.164)	(0.266)	(0.188)	(0.240)
Output Tariffs × Net Importer	-0.70***	-0.74***	-0.87***	-0.50***	-0.69***	-1.35***
	(0.216)	(0.110)	(0.131)	(0.171)	(0.147)	(0.160)
Observations	1,575	1,586	1,546	1,428	1,837	599
R-squared	0.803	0.787	0.823	0.776	0.827	0.858
Panel C: Union Wage Premium						
Output Tariffs	0.32	0.29*	0.60***	0.88***	0.78***	0.50
	(0.322)	(0.161)	(0.210)	(0.249)	(0.181)	(0.336)
Output Tariffs × Net Importer	-0.24	-0.81***	-0.63***	-0.50***	-0.51***	-1.68***
	(0.186)	(0.128)	(0.190)	(0.172)	(0.146)	(0.245)
Observations	1,449	1,562	1,405	1,394	1,809	493
R-squared	0.489	0.363	0.502	0.350	0.491	0.643

Notes: The dependent variable in Panel A is the real median wage earned by union members in a particular industry and state. In Panel B, the dependent variable is the nominal median wage earned by union members in a particular industry and state. In Panel C, the dependent variable is the natural logarithm of the ratio of median union wage and median nonunion wage in a particular industry and state. High-skilled, low-skilled, old, and young are as defined in Table 6. Output tariffs are at the 3-digit industry level and are lagged by one year. All regressions include industry-level controls for skill intensity and concentration and industry-state-level controls for the fraction of casual, household, rural, highly educated, old, and young workers. All regressions include a constant that is not reported and are weighted by the total number of workers in each industry and state pair. They also include state, industry, and year fixed effects. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Current Unionization and Subsequent Trade Policy

	(1)	(2)	(3)	(4)
Dependent Variable	Output Tariffs			
Lagged Union Presence	0.205			
	(0.212)			
Lagged Union Membership		0.052		
		(0.154)		
Lagged Ln(Real Union Wage)			0.002	
			(0.002)	
Lagged Union Wage Premium				0.052
				(0.072)
Constant	0.387***	0.434***	0.201***	0.184**
	(0.067)	(0.035)	(0.057)	(0.087)
Observations	204	204	101	101
R-squared	0.808	0.803	0.751	0.751

Notes: The dependent variable is output tariffs at the 3-digit industry level. The independent variables are lagged by one round. For example, for tariffs in 1998, the lagged independent variables are from the 1993 round. The regressions in columns (3)–(4) exclude the 1999 round, which is why its sample sizes are smaller. All regressions are weighted by the total number of workers in each industry and include year fixed effects. The regressions in columns (1)–(2) include 3-digit industry fixed effects while the cross-sectional regressions in columns (3)–(4) include 2-digit industry fixed effect. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 10: Endogeneity of Output Tariffs

	(1)	(2)	(3)	(4)	(5)
	First-Differenced IV				
Dependent Variable	Δ(Union Presence)	Δ(Union Membership)	ΔLn(Real Union Wage)	ΔLn(Nominal Union Wage)	Δ(Union Wage Premium)
Δ(Output Tariffs)	-0.15	-0.19	-2.02*	-2.26*	-2.33*
	(0.507)	(0.391)	(1.126)	(1.296)	(1.357)
Δ(Output Tariffs × Net Importer)	0.09	0.10	-0.63***	-0.54**	-0.34*
	(0.090)	(0.074)	(0.199)	(0.219)	(0.207)
Constant	0.03	-0.01	-0.76	-0.39	-1.34
	(0.085)	(0.067)	(0.888)	(1.035)	(1.120)
Observations	2,050	2,050	715	715	701
R-squared	0.108	0.088	0.000	0.000	0.000

Notes: The dependent variables in each column are the first-differenced version of the variables defined in Tables 5–8. First-differenced output tariffs are at the 3-digit industry level and are lagged by one year. The instruments are long-lagged tariffs and the interaction between long-lagged tariffs and the net importer indicator. Columns (1)–(2) include all of the control variables listed in the notes for Table 5 in first differences. Columns (3)–(5) include all of the control variables listed in the notes for Table 7 in first differences. All regressions are weighted by the total number of workers in each industry and state pair and include year fixed effects. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Robustness Checks

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Union Presence				Ln(Real Union Wage)			
Output Tariffs	-0.05				0.23			
	(0.056)				(0.195)			
Output Tariffs × Net	0.08**				-0.84***			
Importer	(0.037)				(0.139)			
Delicensing	0.05***				-0.23**			
	(0.016)				(0.106)			
Output Non-Tariff		-0.02				0.24*		
Barriers (NTB)		(0.030)				(0.138)		
Output NTB × Net		0.12**				-1.15***		
Importer		(0.050)				(0.230)		
Input Tariffs			-0.16				0.74	
			(0.133)				(0.669)	
Input Tariffs × Net			0.08**				-0.83***	
Importer			(0.038)				(0.136)	
Effective Rate of				-0.01				0.07
Protection (ERP)				(0.015)				(0.053)
ERP × Net Importer				0.08**				-0.75***
				(0.033)				(0.133)
Observations	3,361	3,361	3,361	3,361	1,853	1,853	1,853	1,853
R-squared	0.567	0.566	0.566	0.566	0.704	0.701	0.702	0.702

Notes: The dependent variable in columns (1)–(4) is the fraction of individuals in a given industry and state that work in unionized activities. The dependent variable in columns (5)–(8) is the real median wage earned by union members in a particular industry and state. All trade protection variables are at the 3-digit industry level and are lagged by one year. The delicensing measure is an indicator variable that is one for 3-digit industries that have been delicensed and zero otherwise. Columns (1)–(4) include all of the control variables listed in the body and notes of Table 5. Columns (5)–(8) include all of the control variables listed in the body and notes of Table 7. All regressions are weighted by the total number of workers in each industry and state pair and include state, industry, and year fixed effects. They also include a constant that is not reported. Robust standard errors in parentheses are clustered at the 3-digit industry level, *** p<0.01, ** p<0.05, * p<0.1.

Table 12: Trade Liberalization, Unionization, and Union Wages - Mechanisms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Ln(Quasirents per Plant)		Ln(Output per Worker)		Ln(Workers per Plant)		Ln(Wage Bill per per Plant)	
Output Tariffs	1.19***	1.50**	-0.51**	-0.05	0.23*	-0.16	0.10	-0.27
	(0.272)	(0.558)	(0.232)	(0.249)	(0.137)	(0.141)	(0.267)	(0.291)
Output Tariffs * Net Importer		-0.15		-0.52***		0.44***		0.42***
		(0.193)		(0.104)		(0.076)		(0.150)
Observations	325	325	2,624	2,624	2,624	2,624	2,624	2,624
R-squared	0.887	0.888	0.848	0.851	0.717	0.723	0.724	0.725

Notes: Output tariffs are at the 2-digit industry level and are lagged by one year. In columns (1)–(2) we use NSSO-based nonunion wages to construct the dependent variable. Because we only use these data for 1993 and 2004, the sample sizes in these columns are comparatively smaller. Columns (3)–(8) use annual data between 1993 and 2004. All regressions include one-year lagged controls for skill intensity and concentration and are weighted by the total output in each industry and state pair. All regressions also include a constant, industry, state, and year fixed effects. Robust standard errors in parentheses are clustered at the 2-digit industry-year level, *** p<0.01, ** p<0.05, * p<0.1.

A Theory Appendix

A.1 A Model of Union Penetration With Efficient Bargaining

In this section we provide further details on the efficient bargaining model introduced in section 2.1. Consider a setup in which a representative firm in an industry and a labor union bargain over both the wage w and employment N. Suppose the firm has the following production function:

$$Q = F(N, v) \tag{9}$$

where v is the vector of all other factor inputs that we will assume to be fixed for tractability. Labor is the only variable input. The prices of the other (fixed) inputs will be taken as given by the firm. The production function given by (9) is assumed to be constant returns to scale and thus it exhibits diminishing marginal product of labor. The firm's utility function (commonly known as the profit function) is:

$$\pi(w, N, v) = PQ - wN - p_v v \tag{10}$$

where w is the wage paid by the firm, p_v is the vector of prices of other factor inputs, P is the output price, and Q is the quantity. The import tariff is denoted by τ, so that $P = P^*(1+\tau)$ where P^* is the world price.

There is also a risk-neutral labor union with the following utility function:

$$U = Nw + (\overline{N} - N)w_a \tag{11}$$

where $\overline{N}$ is union membership and w_a is alternative or outside wage. The Nash bargaining problem is represented by the following maximization problem:

$$Max_{w,N} \quad (Nw + (\overline{N} - N)w_a - \overline{N}w_a)^{\beta}(PQ - wN)^{1-\beta} \tag{12}$$

where β is the bargaining power of workers (of the union) and is assumed to be fixed. After a few

manipulations, the first-order condition with respect to w can be written as:

$$w = w_a + \frac{\beta}{1-\beta}\left(\frac{PQ - wN}{N}\right) \tag{13}$$

The first-order condition with respect to N, with (13) substituted into it gives us,

$$w_a = PF_N \tag{14}$$

where F_N is the marginal product of labor. Let us assume that there is a fixed cost F the union has to incur before it can be operational and start negotiating with the firm. From (13) and (14) above, we can arrive at the following expression for the net payoff of the union, $\widetilde{U}$, which is its net gain from becoming operational or coming into existence:

$$\widetilde{U} = (w - w_a)N - F = \beta(1 - \varepsilon_{Q,N})PQ - F$$

where $\varepsilon_{Q,N} = \frac{NF_N}{Q}$ is the elasticity of output with respect to employment of labor. Note that this is the gain over what these N workers would otherwise get, which would be their outside wage. With a Cobb-Douglas production function, $\varepsilon_{Q,N}$ is a constant. If, instead, we have a CES production function of the form,

$$Q = \left[\theta_N N^{\frac{\sigma-1}{\sigma}} + \sum_i \theta_i v_i^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{15}$$

where σ is the elasticity of substitution between any two factor inputs, θ_N is the weight on labor and θ_i is the weight on any other factor input i in the production function, then we have

$$\varepsilon_{Q,N} = \theta_N \left(\frac{N}{Y}\right)^{\frac{\sigma-1}{\sigma}} = \theta_N^{\sigma}\left(\frac{P}{w_a}\right)^{\sigma-1} \tag{16}$$

The expression above suggests that $\varepsilon_{Q,N}$ is non-increasing in P when $\sigma \leq 1$ (with $\sigma = 1$ being the Cobb-Douglas case). This condition in turn makes the union payoff from (1) unambiguously increasing in P. Trade liberalization reduces $P = P^*(1+\tau)$ and that in turn reduces the union

payoff.[29] Even when $\sigma > 1$, we can have $\widetilde{U}$ going down with trade liberalization since the effect of trade liberalization on PQ can counteract the effect on $1 - \varepsilon_{Q,N}$. Note that the union will be in place only if $\widetilde{U} > 0$. If $\widetilde{U}$ is decreasing in $P = P^*(1+\tau)$, then trade liberalization makes union formation less likely or alternatively, makes deunionization more likely.

To examine the impact of trade on the union wage, we need to substitute (14) into (13). This yields

$$w = w_a \left[1 + \beta \left(\frac{1 - \varepsilon_{Q,N}}{\varepsilon_{Q,N}}\right)\right] \tag{17}$$

For a given w_a, Eq. (17) suggests that there is an inverse relationship between w and $\varepsilon_{Q,N}$. We know from (16) that $\frac{d\varepsilon_{Q,N}}{dP} \gtreqless 0$ as $\sigma \gtreqless 1$. Therefore, trade liberalization will increase w for given w_a when $\sigma > 1$ and decrease w for given w_a when $\sigma < 1$. Another way of stating this is that w/w_a will increase with trade liberalization when $\sigma > 1$ and decrease with trade liberalization when $\sigma < 1$. Thus, how trade liberalization will affect the union wage and union-nonunion wage differential becomes an empirical question. Next, to derive Eq. (3), we can simply rearrange (13).

A.2 Trade and Union Penetration with Endogenous Firm Exit

In this section we describe the details of the Kremer and Olken (2009) model with international trade. Across all firms within an industry, the difficulty of organizing workers in each firm by the union, given by a cost c, is distributed uniformly on the unit interval $[0, 1]$. Each firm sets employment to maximize profits at a basic wage. This basic wage equals the effective wage in home production, which is the alternative sector of employment for each worker. In home production, we assume a Ricardian constant-returns-to scale production function with only labor as the factor

[29] At first, it might seem counterintuitive that in a model with factors other than labor held fixed, the elasticity of substitution has an important role to play. To understand this, suppose we have in the model only two factor inputs, namely labor and capital, and that capital is held fixed. What the elasticity of substitution determines is the responsiveness of capital intensity (capital-labor ratio) to a change in the wage rate. So for example in the perfect complements case where the elasticity of subsitution is zero, the capital intensity will be fixed (Leontief case). In other words, it is just the fixed factor that will determine the amount of labor to be used. With $\sigma > 0$, as wage goes down the firm will be willing to use more and more labor and will be less constrained by the amount of the fixed capital it owns (or has access to). If capital and labor are perfect substitutes (σ goes to infinity), the amount of the fixed capital possessed is not a constraint at all in the firm's expansion in response to a fall in the wage. In other words, σ tells us how much of a constraint the fixed factors are for a firm and how easily it can keep adding more labor to expand output as wage keeps falling.

of production. If the firm is unionized, the union is able to extract a lump-sum amount from the firm, which is the sum of additional wages for its members, α, and the expenditure on organizing, B. To keep things simple, α and B are treated as constants in the Kremer-Olken model. Denoting by π the maximized value of the excess of revenues over the basic wages paid (not including α or B), we can write the present discounted value of a firm as

$$V = \frac{\pi - \alpha - B - I}{r + \delta(I)} \tag{18}$$

where I is unobserved investment and includes expenditure on avoiding negligence that could lead to costly lawsuits and research and development to remain competitive with potential rivals. r is the discount rate. Firms are subject to possible negative productivity shocks that can lead them to exit with hazard rate δ, which is a decreasing function of the investment denoted by I, leading to $\delta_I < 0$. Additionally, $\delta_{II} > 0$. The firm maximizes V with respect to I. As shown by Kremer and Olken (2009), this optimum I is decreasing in $\alpha + B$, which in turn makes δ increasing in $\alpha + B$. Thus the greater is the union's demand for $\alpha + B$, the lower are the firm's net profits and lower is the incentive for the firm to invest and the higher is the firm's probability of exit. If we extend the model to trade by assuming π is an increasing function of the import tariff τ, then by differentiating the first-order condition we can see that the optimal investment I is also increasing in the tariff. The reason is that the tariff increases the payoff from the higher probability of survival and therefore the firm is willing to invest more in it. Thus, the exit hazard rate δ is decreasing in the import tariff.

Next, let us denote the attractiveness of a union to the workers by $A(\alpha, B, \tau)$. Let us further assume that this attractiveness is the present discounted value of rents received by workers. Therefore, we have

$$A(\alpha, B, \tau) = \frac{\alpha}{r + \delta(\alpha + B, \tau)} \tag{19}$$

If Ψ is the number of unionized firms, then the union's organizing budget equals $B\Psi$. Further if the organizing power of the union is proportional to both the attractiveness to workers and its organizing budget, then, following Kremer and Olken (2009), the effective organizing budget (or

the efective organizing power) of the union equals $A(\alpha, B, \tau)B\Psi$.

Normalizing the total measure of all firms in an industry to unity, Ψ becomes the fraction of firms that are unionized. Let us say the union is able to unionize firms that are below the threshold unionizing cost of γ. During an instant of time a fraction $\delta(0, \tau)$ of the non-unionized firms and a fraction $\delta(\alpha + B, \tau)$ of the unionized firms exit due to a negative shock. In the steady state, an equal number of firms will need to enter to keep the number of firms constant. For the budget constraint to hold, the effective organizing cost should equal the effective organizing budget, which means

$$[\delta(\alpha + B, \tau)\Psi + \delta(0, \tau)(1 - \Psi)] \int_0^{\gamma} cdH(c) = A(\alpha, B, \tau)B\Psi \tag{20}$$

where $H(c)$ is the distribution function of c. The above equation in turn can be written as

$$[\delta(\alpha + B, \tau)\Psi + \delta(0, \tau)(1 - \Psi)]\frac{\gamma^2}{2} = A(\alpha, B, \tau)B\Psi \tag{21}$$

The other steady condition is that the number of unionized firms should not change, which means that the number of new firms that the union is able to organize equals the number of unionized firms that get destroyed by negative technology shocks (exit). This condition can be written as

$$[\delta(\alpha + B, \tau)\Psi + \delta(0, \tau)(1 - \Psi)]\gamma = \delta(\alpha + B, \tau)\Psi \tag{22}$$

Dividing the steady state budget constraint condition by the other steady state condition and inserting the expression for $A(\alpha, B, \tau)$ into it we have

$$\gamma = \frac{2\alpha}{[r + \delta(\alpha + B, \tau)]\delta(\alpha + B, \tau)} \tag{23}$$

Because δ is decreasing in τ, for given $\alpha + B$ we have γ increasing in τ. The intuition for this is that firms below a threshold unionization cost given by gamma get unionized. As the tariff goes down, the profits of each firm go down for a given level of investment. As a result, firms invest less and the probability of firm death increases, which increases the replacement rate of firms. In other words, the proportion of young firms will be higher in the population of firms, the young firms

being the ones on whom the union spends to unionize its workers. Thus, the threshold unionization cost, gamma below which firms are unionized has to go down for the union to maintain its budget constraint. This means that in each cohort of firms, a smaller proportion of firms is unionized. From the second steady state condition, we can see that, if we impose the restriction that $\frac{\delta(0,\tau)}{\delta(\alpha+B,\tau)}$ is non-decreasing in τ, we have Ψ increasing in τ for given $\alpha + B$.

A.3 Trade and Union Wages and Membership with "Open-Shop" Unions

In this section we provide further details of the Naylor and Cripps (1993) and Booth and Chatterji (1995) models. Let the pool of workers available for employment in a sector be normalized to unity. In addition, for a given wage w, let the labor demand of the industry's representative firm be given by $n(w)$. Also, let the per member cost of running the union be h, which we assume to be a constant. For a not-for-profit union, this per-member cost will equal the fee (dues) per member. Also, let a worker's alternative income be β. This could represent unemployment benefits or income from working in the informal sector. Since the negotiated wage will apply to both union members and non-members who find employment in the sector, assuming that the probability of employment is not affected by union membership, we have the expected utility for an individual from joining (EU^J) and not joining (EU^{NJ}) the union as the following:

$$EU^J = n(w)[u(w-h)+\delta] + [1-n(w)]u(\beta),$$

$$EU^{NJ} = n(w)u(w) + [1-n(w)]u(\beta)$$

where δ is the benefit from an excludable private good such as a grievance procedure that the union provides or the utility from adhering to the norm of union membership, where different members could value this benefit differently. However, following Naylor and Cripps (1993) and Booth and Chatterji (1995), each member is assumed to put a different valuation on following this norm for given membership. Thus an individual joins the union if

$$EU^J - EU^{NJ} > 0 \Rightarrow \delta > u(w) - u(w-h) \tag{24}$$

Let δ vary across individuals for given membership. As explained in the text, we arrange individuals in descending order of their δ's. Noting that this ranking should hold for any given level of membership and assuming that it dominates the effect of increased membership on utility from following the norm, in Figure 1 we have a downward sloping δ curve with respect to union membership M. While Booth and Chatterji have the union's objective function given by the median member's expected welfare gain from union-firm wage negotiations given by $n(w)[u(w-h)+\delta^{median}-u(\beta)]$, Naylor and Cripps have the union objective function to be the excess of the negotiated wage over an exogenous strike pay (pay in case there is a strike if negotiations fail). Note that if negotiations fail, there is a strike which means that in the Naylor-Cripps model only non-union workers can be employed. On the other hand, in the Booth-Chatterji model, negotiation failure leads to zero output and employment, in which case workers get their alternative income β. As explained in the text, in both models the negotiated wage increases in union membership, holding other things constant. In both cases the membership cost given by $u(w)-u(w-h)$ is downward sloping with respect to M by the concavity of the utility function and the negative relationship between labor demand and wage. The intersection of the two curves gives us the endogenous union membership, which means for the marginal person joining the union it should be the case that

$$EU^J - EU^{NJ} = 0 \Rightarrow \delta = u(w) - u(w-h) \tag{25}$$

When we introduce trade, we can think of the labor demand curve as being $n(w,\tau)$ instead of $n(w)$, which we had in the closed economy. τ refers to the import tariff, with partial derivative $n_w < 0$ and $n_\tau > 0$. With tariff liberalization, at any given membership, the negotiated wage will go down since the value of the marginal product and profits are lower at each employment level and there are less rents to share. Note that the wage is determined (negotiated) first and, given that wage, the firm determines its profit-maximizing employment level. Thus the membership cost curve $u(w)-u(w-h)$ in Fig. 1 shifts up due to the concavity of the utility function. Both union membership M and the negotiated wage w will go down.